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*Machine for testing the strength of wet paper, described on page 309*



## Film Scanner for Testing Television Transmission

By W. A. KNOOP  
*Television Research Department*

response of the eye is not at all like that of the ear to certain types of distortion. The most satisfactory way to test television circuits, therefore, is to transmit television signals over them, and to judge the results visually.

In making such tests it is desirable to transmit the same scene or series of scenes over

**J**UST as program broadcasting requires extensive networks of cable circuits to connect studios and radio transmitters, so television broadcasting will need similar cable connections for its most effective growth. To a limited extent the Bell System has already supplied such facilities\* on an experimental basis. The development and testing of these facilities is complicated both by the very wide band of frequencies that must be transmitted and by the varied requirements for television transmission. In some respects these are much more severe than those placed on multi-channel telephone circuits, even when the total band width is the same. A circuit entirely satisfactory for high-quality telephone transmission might not be satisfactory for television transmission because the

the cable again and again. For this reason a motion-picture film is the best source of the transmitted material. With this method the picture frames on the films are scanned successively by some form of television scanner, and the resulting television signals, suitably amplified, are transmitted over the circuit. Each frame is scanned in a series of lines one above another, and thus there is a vertical as well as a horizontal component of the scanning. In using film, it seemed desirable to let the motion of the film provide the vertical component, and thus to simplify the scanning equipment. Since the ordinary motion-picture projector moves the film intermittently, a suitable transmitter for these tests was developed by modifying a Western Electric film recorder to secure steady motion of the film and the other features that were required.

\*RECORD, Feb., 1938, p. 188; June, 1939, p. 312; Oct., 1939, p. 34.

The complete machine is shown in Figure 1. At the extreme left is the scanning equipment, and the rectangular case next to the right carries the projection lamp. Light from this lamp passes through a lens in one side of the case and then through an opening in the film case adjacent to it, where it is refracted by a right-angle prism to pass through the film and into the scanning equipment.

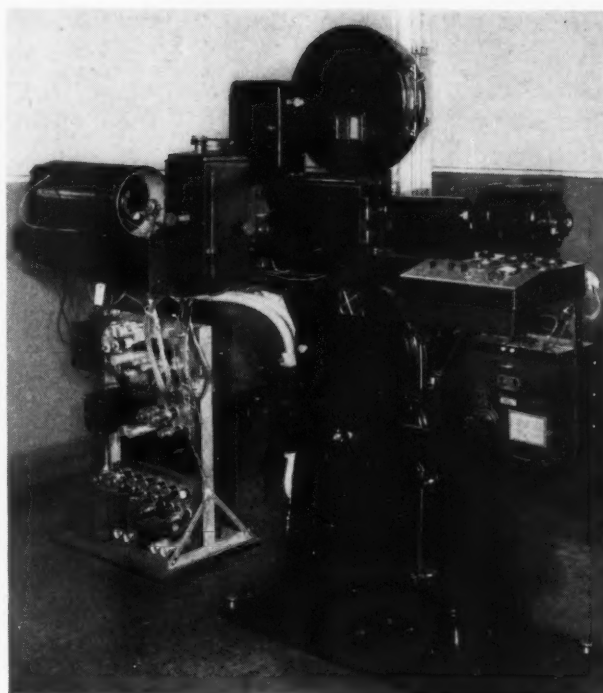


Fig. 1—The film-scanning machine

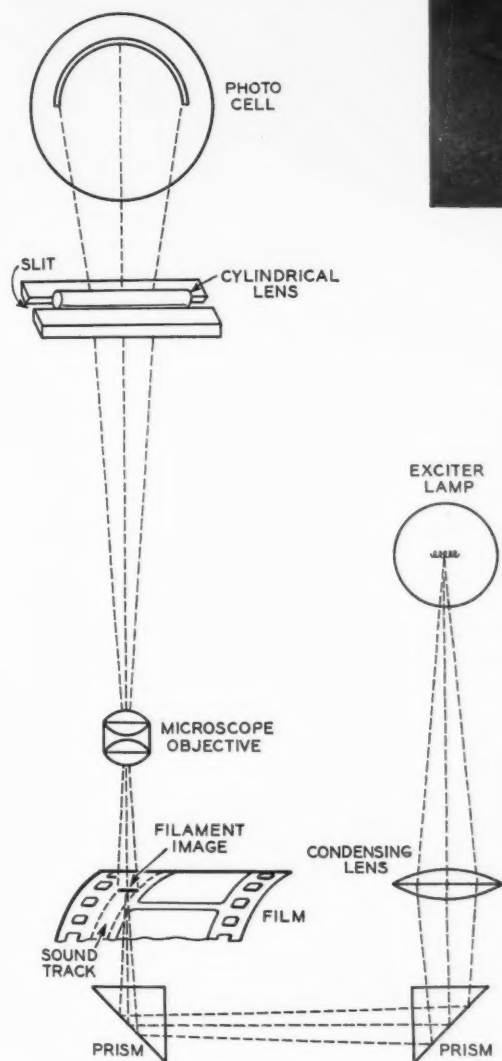


Fig. 2—Path of light for sound scanning

June 1941

Just above the left end of the film cabinet is the equipment for sound pick-up. It includes a photo-electric cell, lenses, and certain miscellaneous equipment. The film supply reel is at the upper center, and the film take-up reel is below it and just beneath the film compartment. At the right is the motor that drives the film. The lamp housing is mounted on a hinged bracket, and may be swung out to give access to the film cabinet.

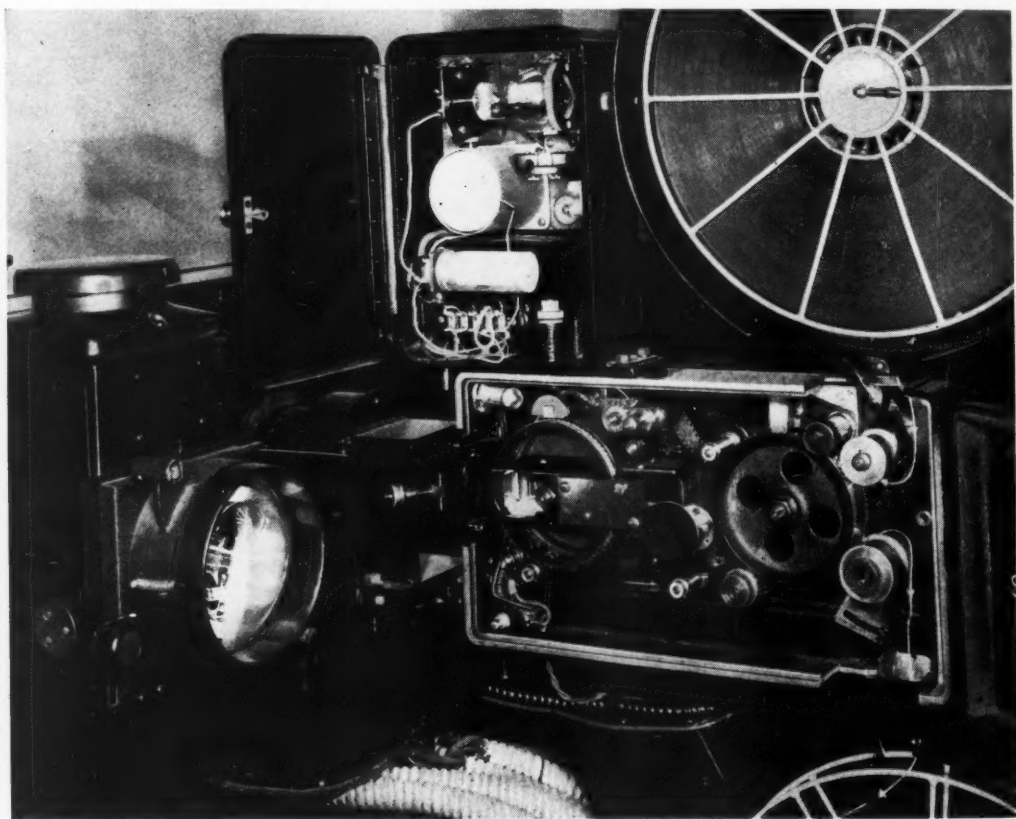
A close-up of the apparatus with the various doors open is shown in Figure 3. The film passes down from the film magazine, over the top of a film sprocket that pulls the film from the magazine, thence around the main sprocket at the left, back against the bottom of the first sprocket, and down to the take-up reel. The rectangular prism is within the main sprocket at the left center, whence the light passes through the

film and is formed into an image of the film on the cathode of the dissector tube which is used for scanning. The sound gate is at the top of the main sprocket, whence the light passes through the sound track on the film, through an optical system, and to the photo-electric cell in the cabinet above. Light for the sound pick-up comes from a rear compartment of the photo-electric cell cabinet, down through a prism, and thence horizontally through the semi-circular bridge just above the main sprocket and then through another prism up through the film. The path of this light is shown in Figure 2.

The rim of the main sprocket overhangs its shaft to provide space for the prism and to enable light to be transmitted through the film for tele-

vision scanning. To meet this latter requirement, the rim is a lattice, with its outer edge supported by crossbars spaced so as to fall between the frames on the film. Light for the sound pick-up does not pass through the rim of the sprocket, and thus there is no interruption of the sound beam.

An ordinary motion-picture film is projected at the rate of twenty-four frames per second, while present television standards call for the equivalent of thirty frames per second. Moreover the picture is scanned in 441 lines interlaced. This means that each frame is scanned twice, each scanning passing over alternate lines; on the first scanning the odd-numbered lines will be covered, and on the second, the even-numbered lines. Since the film is moving steadily, this inter-



*Fig. 3—Close-up of film chamber with sound pick-up cabinet above*

laced scanning could readily be accomplished by printing each frame twice. On the first of each pair of frames, the odd-numbered lines would be scanned, and on the second frame, the even-numbered lines. Under these conditions, if the film were moved at the rate of forty-eight frames per second, the picture would be at the rate of twenty-four frames per second. By printing every other frame three times instead of twice, and running the film at the rate of sixty frames per second, the desired thirty-per-second frame speed is secured. A specially printed film is thus required for the scanner, but since only a small number of representative subjects is required, the additional cost of the film is more than offset by the resulting simplicity of the apparatus and the ease of maintenance.

Although the continuous motion of the film avoids the necessity of

vertical scanning so far as the picture itself is concerned, a small amount of vertical scanning is used because the distance between frames on a motion-picture film is greater than the equivalent "blanking" time between television images. The difference is about seven per cent of the frame time or about thirty lines of the picture. To avoid this loss, about eight per cent of vertical scanning is supplied. The scanning thus follows the image as the film moves down so that the image is scanned about eight per cent longer than it otherwise would be.

The complete film transmitter consists of a number of bays of equipment, including a monitoring bay, as well as the film-scanning machine itself. It is installed in the Graybar-Varick Laboratories, and has proved very useful in studies made of the three-megacycle television channel between New York and Philadelphia.

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THE JOHN PRICE WETHERELL MEDAL of *The Franklin Institute of Philadelphia* has been awarded to *Harold S. Black* for his technical contribution to the modern efficiency of long-distance telephony, particularly his development of the negative-feedback amplifier. The award was made on May 21 at the Medal Day exercises of the Institute



## Ten-Frequency Airplane Radio Equipment

**W**ITH the steady growth in the size of commercial airplanes and in the length and number of non-stop flights, there has been a corresponding development in the radio facilities carried aboard. The radio transmitters and receivers used for communication with ground stations are now required to meet a much wider field of use. With the extended flying radius planes span more airline divisions, and since each division has its own day and night frequencies, the sets must accommodate a wider range and greater number of frequencies and be able to

shift from one frequency to another with a minimum of delay. Ten or a dozen years ago, single-frequency equipment\* was adequate. Within a few years, however, the growing air transport industry required three-frequency equipment.† To meet still more expanded needs, the Western Electric Company has now made available ten-frequency equipment developed by the Laboratories. The major features of the new ten-frequency transmitter and receiver are described in the following articles.

\*RECORD, Oct., 1930, pp. 59-76.

†RECORD, May, 1933, pp. 262-278.

# Ten-Frequency Transmitter

By J. G. NORDAHL  
*Radio Development Department*

THE 27A radio transmitter provides ten preselected frequencies in the ranges from 300 to 500 kilocycles and from 2 to 15 megacycles. Its rated carrier output is 125 watts, but at the very high and very low sections of the frequency range the output is somewhat less. One of the most interesting features of this transmitter, and one that to a large extent determined its physical design, is the means provided for quickly shifting the carrier frequency. A Western Electric 5-type quartz plate, which serves to control the carrier frequency, and the various radio-frequency tuning coils in the transmitter, are mounted in a light-weight unit. Ten of these units, one for each preselected frequency, are plugged into position in an aluminum turret that may be rotated to bring the unit for the desired frequency into contact with the terminals of the transmitter.

This system has several advantages. First, unlike some compromise methods, the arrangement provides for tuning the circuits to maximum efficiency at each frequency; and second, the leads between the vacuum tubes and the tuning elements are short and fixed in length, making it possible to tune for any of the ten selected frequencies with equal efficiency and with freedom from spurious oscillations. The turret and tuning units were borrowed bodily from a transmitter originally developed by the Laboratories in 1936 and 1937 for

the Douglas DC4 planes then building. That transmitter is believed to have been the first for commercial airplanes that used the turret principle of frequency shifting. Since the turret is the central and largest part of the equipment, it more or less determines the overall dimensions. The other apparatus is placed behind, below or around it in the most suitable

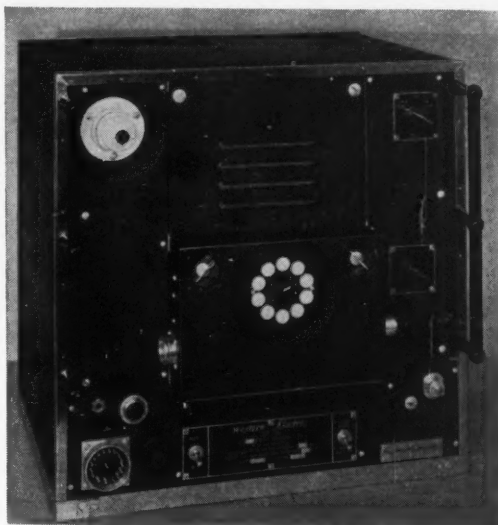


Fig. 1—Front view of the 27A radio transmitter for transport service

locations. The assembly is made compact so as to occupy as little space in the plane as possible, but at the same time it has been possible to provide ready accessibility to all parts. This is brought out in the accompanying photographs.

A front view of the transmitter is shown in Figure 1. The indicator,

which resembles a telephone dial, shows which of the tuning units is in the transmitting position. These units may be inserted or withdrawn by removing the rectangular front plate above the indicator. If the unit to be replaced is not in the proper position at the moment, the cover over the indicator is dropped back on its hinge



Fig. 2—Remote control unit for the 27-type radio transmitter

and the turret is rotated by turning a stout steel key as shown in the photograph on page 302. Under ordinary operating conditions, the turret is turned electrically by operating a ten-position switch either at the right center of the transmitter or at the control unit, Figure 2, which will be located conveniently to the pilot. A small dynamotor for supplying intermediate voltage is incorporated in the transmitter, and mechanical power for turning the turret is obtained from it through an electromagnetic clutch controlled by these switches. Provision is made for extending a flexible shaft from the drive

unit of the transmitter to the receiver, so that when the units are operated in conjunction, both the transmitter and receiver will be turned together.

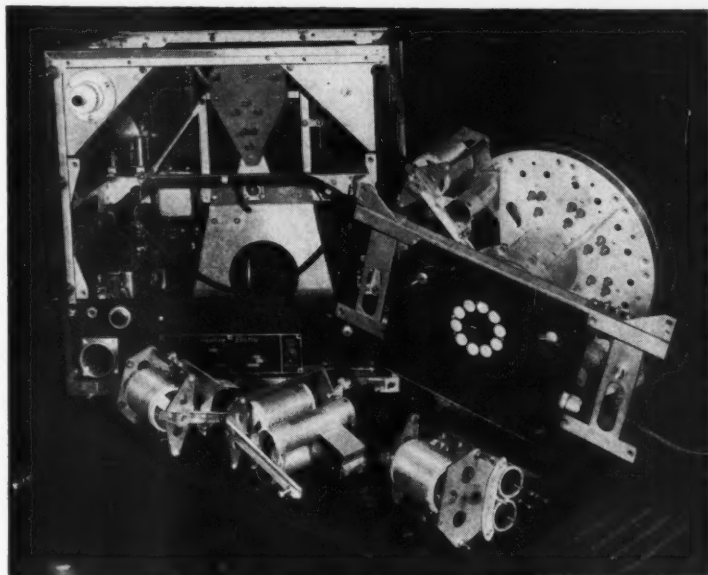
When access to the transmitter is needed for maintenance purposes, practically the entire casing of the transmitter can be removed. The back cover is removed by one turn of each of the four corner screws, and when this is off, the top and two sides, which are in one piece, slip off without the necessity of removing any other screws or fastenings. After the two side pieces on the front panel have been removed, the turret and the reinforced front of the cabinet, which carries the front bearing of the turret, may be pulled out. At this stage, the transmitter appears as in Figure 3, where some of the tuning units have also been removed from the turret to show their construction and "plug-in" arrangements. On the wedge-shaped plate at the rear center of the transmitter may be seen the wire clips by which connection is made between a tuning unit and the circuit of the transmitter.

The vacuum tubes and the intermediate-voltage dynamotor are accessible from the rear as shown in Figure 4. A small fan operates from the dynamotor to draw air through a spun-glass filter and exhaust it through louvres at the front and back near the higher-powered vacuum tubes. A high-voltage dynamotor is also employed. This is mounted separately, frequently under the pilot's seat, and is started and stopped electrically from the control unit of the transmitter. Either a 12-volt or 24-volt power supply may be used. A multi-contact plug and jack used for connecting to the dynamotor in the transmitter is wired to connect the filaments and relays in series or paral-

lel depending on whether the primary battery supply is at 24 or 12 volts. Every part of the transmitter has been carefully designed and chosen to insure the lowest weight consistent with reliability of performance. Both transmitter and power unit have successfully passed all of the very stringent Civil Aeronautics Authority tests and bear approved-type certificates. These tests not only include the usual electrical tests for radio equipment, but require satisfactory operation when the equipment is subjected to an extremely wide range of temperatures, reduced air pressures corresponding to high altitudes, a long period of high humidity, large amplitudes of vibration over a wide range of frequencies, and a series of drop or shock tests.

Many airlines operating in foreign countries and domestic private flyers who wish to communicate with ships at sea or to fly to foreign countries, require transmission in the low-frequency range of 300 to 500 kc. For these frequencies a tuning unit has been developed which mounts on the transmitter turret in the same manner as those for the higher frequencies. A long trailing-wire antenna is usually employed for low-frequency operation since it is much more efficient than the fixed antenna normal for the high frequencies. Accordingly, provision has been made for installing an additional antenna terminal at the rear of the transmitter for connection to a

trailing-wire antenna. To facilitate changing from a high to a low frequency, the low-frequency tuning unit is fitted with an extra contact pin which connects it to the rear antenna terminal when the tuning unit is rotated into operating position. With this arrangement the low-frequency tuning unit may be used in any turret position, and no switching operation on the part of the pilot is required for any high or low frequency other than the movement of the channel selector switch to the desired position as noted above. The tuning units are usually adjusted at the time of installation for operation at one frequency into a fixed length of antenna. A thermocouple in the transmitter, how-



*Fig. 3—The complete turret may be readily removed from the transmitter to give access to the apparatus beneath it*

ever, provides for remote indication of the antenna current so that, if desired, the length of the trailing-wire antenna may be adjusted from the pilot's position in the plane for maximum antenna current.

Voice ("PHONE") transmission is



*Fig. 4—A. K. Bohren inserts a tube in the new ten-frequency transmitter during an inspection of one of the early samples at the Laboratories*

used almost exclusively for domestic flying in the United States, but many airplanes operating overseas use continuous wave ("cw") or modulated continuous wave ("mcw") telegraph transmission. These types of emission have been provided, and sidetone is delivered to the pilot's headphones when operating on all of these emis-

sions. Facilities have also been provided in the equipment for "facsimile" emission for high-speed keyed transmission, such as would be needed for transmission of weather maps and news. Any one of these types of emission may be selected by an emission selector switch on the transmitter panel—at the upper right in Figure 1—which is duplicated at the remote control unit. Another switch, the "CODE SEND-RECEIVE" switch, also duplicated at the remote control unit, is used only during telegraph transmission to operate the antenna transfer relay and place the circuits in readiness for operation of the telegraph key or facsimile apparatus. The "CODE SEND-RECEIVE" switch and the master "ON-OFF" switch on the remote control unit afford control of the transmitting equipment when the frequency and emission selector switches on the transmitter are placed in the "REMOTE" position. When a new frequency is being selected, a light on the control unit is energized until the turret arrives at the desired position, at which time the lamp goes out, indicating that the circuits are ready for operation. An indicating light for this purpose is not provided at the transmitter because the turret position is indicated by the dial.

## Ten-Frequency Receiver

By HOWARD MORRISON  
*Radio Development Department*

THE receiver for the ten-frequency airplane equipment covers the range from 2 to 15 megacycles. It is of the super-heterodyne type, and employs quartz crystals for control of the oscillator circuit. Ten quartz plates and ten sets of tuned circuits are thus required when the receiver is fully equipped. While the transmitter uses a turret which is rotated to a different position for each one of the ten frequencies which it houses, the receiver has fixed crystals and tuning circuits, which are selected electrically by a ten-point switch. The size and appearance of the receiver is indicated in Figure 1. It is mounted like the drawer of a filing cabinet in the radio rack of the airplane.

Besides selecting the quartz plate, the frequency switch also connects appropriate tuning inductances into each of three circuits. These inductances are small coils, and thirteen of them are required to cover the range from 2 to 15 megacycles. There are three tuned circuits in the radio-frequency stages of the receiver; and thus thirty coils are required to obtain the full complement of ten frequencies. They are mounted in three separate compartments in front of the quartz plates as shown in Figure 2. The switch

is operated either from the control unit, shown in Figure 3, or indirectly from the transmitter control unit. When the frequency of the transmitter and receiver are to be changed together, a flexible shaft connects the transmitter drive to the receiver switch; but when the receiver is to be controlled independently, a motor drive is operated from the control unit over an 11-conductor cable. Relays are included in the receiver to permit it to be operated in conjunction with the transmitter from the push-button on the microphone. When the transmitter is switched on, the receiver is disabled and side-tone is connected to the telephone.

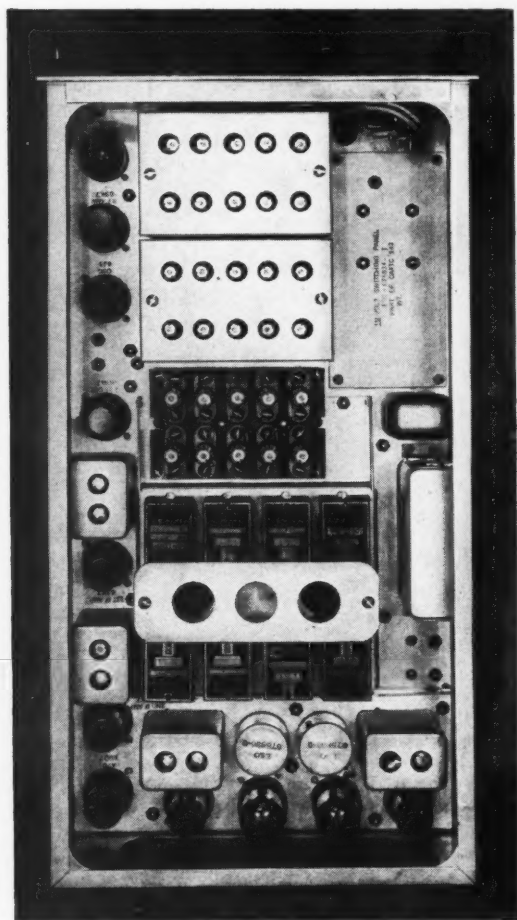
The receiver includes an antenna tuning circuit followed by a radio-frequency amplifier working into a first detector through a band-pass filter. The antenna circuit and filter



Fig. 1—The 29A radio receiver is shaped like the drawer of a filing cabinet to fit the radio rack of the airplane

provide adequate selectivity to reduce image frequencies to negligible values. Two vacuum tubes are included in the 385-kc intermediate frequency amplifier, and all intermediate-frequency transformers are doubly tuned, making each serve as one section of a band-pass filter. The detection function is separated from the automatic volume control function by the use of

any of the receivers, and the provision of double output circuits enables one pilot to listen to the beacon or marker signals as well as to the speech channel without affecting the



*Fig. 2—When the receiver is removed from its casing, all the major pieces of apparatus are readily accessible*

two tubes, thus improving both functions. Two audio-output channels, each fed from a separate final amplifier tube, are provided. Each of the two pilots can connect his headset to



*Fig. 3—Remote control unit for the 29A ten-frequency receiver*

reception of the other pilot who may be listening to speech alone.

A separate oscillator operating at 386 kc is provided for continuous-wave telegraph reception. This oscillator beats with the 385-kc intermediate frequency to give a 1000-cycle telegraph signal. An on-off switch and a frequency control are provided for this service on the front of the receiver just above the power receptacle at the left.

This new receiver is designed to operate on any power supply now used in airplanes or likely to be adopted in the near future. Most planes are now equipped with 12-volt storage batteries, with a few using

24 volts. A dynamotor mounted in the receiver is available for either of these voltages, and the filaments and control circuits are connected in either a series or a parallel arrangement to conform with the supply voltage. The dynamotor is connected to the receiver through a multi-conductor plug and jack; and the plug attached to the dynamotor for each voltage is so strapped as to give the correct arrangement of the filament and control circuits for the voltage applied. The receiver is also arranged to accommodate a tapped transformer when the power supply is either 400 or 800 cycles at 110 volts.

An exceptionally good automatic volume control has been provided. It operates over a range from one micro-volt to two volts, aided over the upper part of the range by a volume limiter consisting of a biased rectifier

tube connected across the grid-to-cathode circuit of the first amplifier.

Every effort has been expended to make the receiver as reliable a unit as possible. Flameproof wire of exceptional resistance to humidity has been employed throughout, and all components were chosen with care and subjected to rigid tests in the assembled receiver. In addition, the receiver has been subjected to the acceptance tests of the Civil Aeronautics Administration which include operation for a long period at high temperatures and humidity, tests at low temperatures, and vibration and shock tests. Equipped for ten frequencies and with the electrical drives, it weighs only a little over twenty-seven pounds; and this light weight, combined with its accessibility for maintenance, makes it well suited to the transport field.

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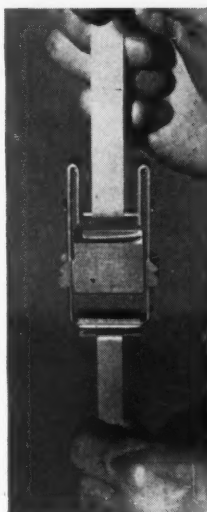
## WET STRENGTH TESTER FOR PAPER

A method for the reliable determination of the tensile strength of paper when wet has been developed in the Laboratories under the direction of J. M. FINCH. Such tests are important, for example, in the case of paper used for making phenol fibre. To avoid tearing, the paper should have the greatest possible wet strength consistent with high absorbency for the water solution or suspension of synthetic resins. In early tests water was applied by a pipette, or brush, to the paper while on the testing machine. This method of application was unsatisfactory because successive speci-

mens were not uniform and sometimes were damaged.

In the new method a strip of paper is looped under a horizontal rod in an assembly which is held by the lower jaws of a paper-testing machine. The two ends of the loop are clamped in the upper jaws. Below the rod is a container filled with water which can be raised so as to immerse the paper.

The apparatus gives reliable results in wet strength tests on weak specimens such as absorbent paper, and also on very thin paper like that of condenser tissue which is only 0.0003 inch thick.





## Dielectric Strength Tests on Aerial Cable

By W. W. STURDY  
*Protection Development*

The cables tested had all been supplanted and were to be dismantled. Each section was terminated at one end in standard cable terminals mounted on a pole in the normal fashion and the other end was insulated and capped. Before testing, the sections were carefully inspected to see that all drop wires had been disconnected. Plant forces in the area were advised of the tests and the cable sheath was always maintained at ground potential as an additional safety measure.

Increasing voltage was applied to cable pairs until momentary insulation failure occurred and in another test 2400 volts r.m.s. was applied repeatedly until permanent failure resulted. That was the minimum voltage which would definitely cause temporary failure on every application. The damage to the insulation varied at random from a burn the size of a pin head to complete destruction for an inch along the wire.

Of the fifteen cable sections tested, several were located in outlying areas at Greenfield, Massachusetts, and mobile testing equipment was used. The apparatus was carried in three units: a three-and-one-half-ton truck which housed the power equipment, a one-and-one-half-ton truck for the control equipment, and a station wagon which pulled a trailer in which were an oscillograph and a dark room for processing the film. The normal output of the power-supply unit was

**F**OR many years the Western Electric Company has tested the dielectric strength of new cables before shipment. Their strength has been found somewhat less after several years in service and the Laboratories has recently carried out field studies to determine the factors responsible for this change; also the voltage required to produce permanent insulation failure. Tests were made on 19-, 22- and 24-gauge exchange cables which had been in service for periods ranging from six to thirty years. The results showed that the average dielectric strength of such cables is about seventy-five per cent of that of new ones. This loss is due to partial destruction of insulation from overvoltages or mechanical causes, rather than to age-deterioration of the paper insulation.

9 kva single- or three-phase, but several times this amount could be drawn for short intervals. Two phases of the three-phase generator were used to provide auxiliary power for the lights, motors and vacuum-tube filaments and the other to supply the main testing power. Both main and auxiliary power were at 240 volts and 60 cycles.

To ensure the safety of the testing group—an engineer, a record-keeper and an oscillographer—testing voltage could be applied to the cable only by push-button switches. Operation of these switches was the duty exclusively of the engineer, who alone made the necessary connections to the cable terminal.

In the control truck were a timer for determining the duration of the testing voltage, a 25-kva step-up transformer, and the necessary control and safety equipment. The timer consisted of a condenser-resistance circuit and two mercury-vapor tubes large enough to pass the test current during the timed interval. A string

oscillograph with three elements was used. Its operation was synchronized with the test voltage by a sequence switch whose cams controlled the starting of the oscillograph, application of the test voltage, photographing the identifying clock, and resetting for the next test. The film speed was approximately one foot per second and each test covered about one foot of film.

The two conductors of the pair under test were strapped at the terminal and all the other pairs were bunched, connected to the sheath and grounded. Test voltage was applied, in series with a current limiting resistance, between the test pair and all the others (see Figure 3). Duration of the voltage and series resistance could be varied, but were maintained constant for any one pair. Since application of 2400 volts generally involved destruction of insulation on pairs other than the test pair, it was necessary to make the increasing-voltage test on all pairs in the cable before starting the other types of test.



*Fig. 1—Mobile equipment for insulation tests on aerial cable*

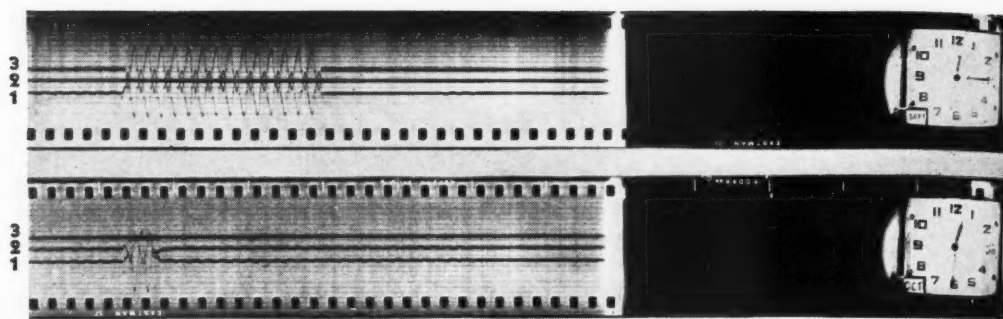


Fig. 2—Top, breakdown current (3) on application of 2400 volts as recorded at (1); bottom, breakdown voltage (2) with 2520 volts applied as shown at (1)

After the insulation on all pairs in the cable had been destroyed, a check was made to determine which pairs were crossed. The number of conductors involved in each failure was generally two, but in some cases there were as many as fourteen. A list of crosses for each cable was turned over to the Associated Company concerned and the crosses were located by their regular cable splicers with cable test sets. Each cross was repaired and short pieces of the damaged wire involved, including the destroyed insulation, were filed in appropriately

labeled envelopes. After a cable section had been repaired, both types of test were repeated to investigate the effect of the insulation destruction and repair on the dielectric strength of the cable.

These studies provided a large amount of data in the form of oscillograms. They showed that the insulation strength of cable pairs in service is somewhat less than that of new ones but that the decrease is not sufficient to affect the usefulness of the older types of cable under normal operating conditions.

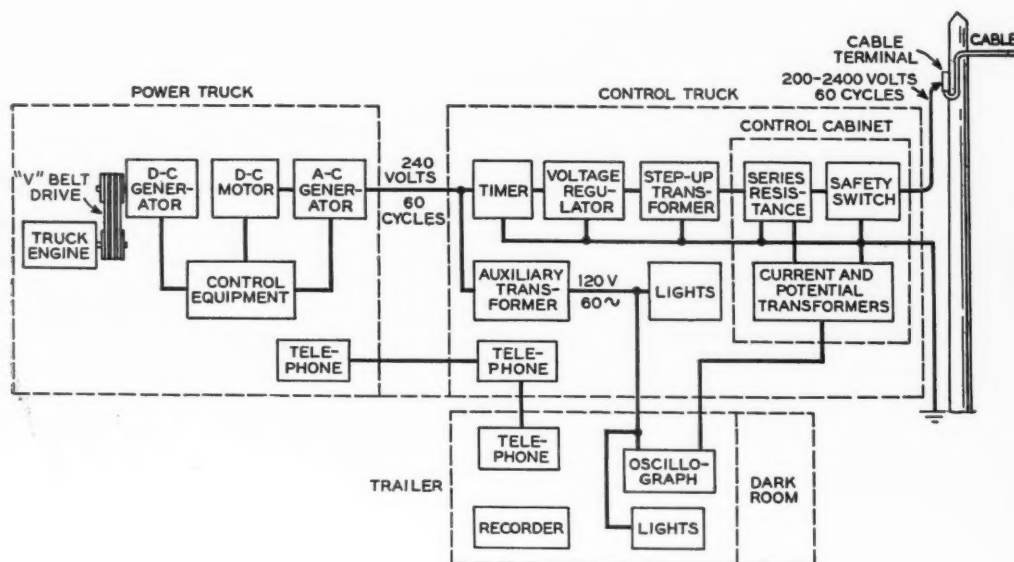
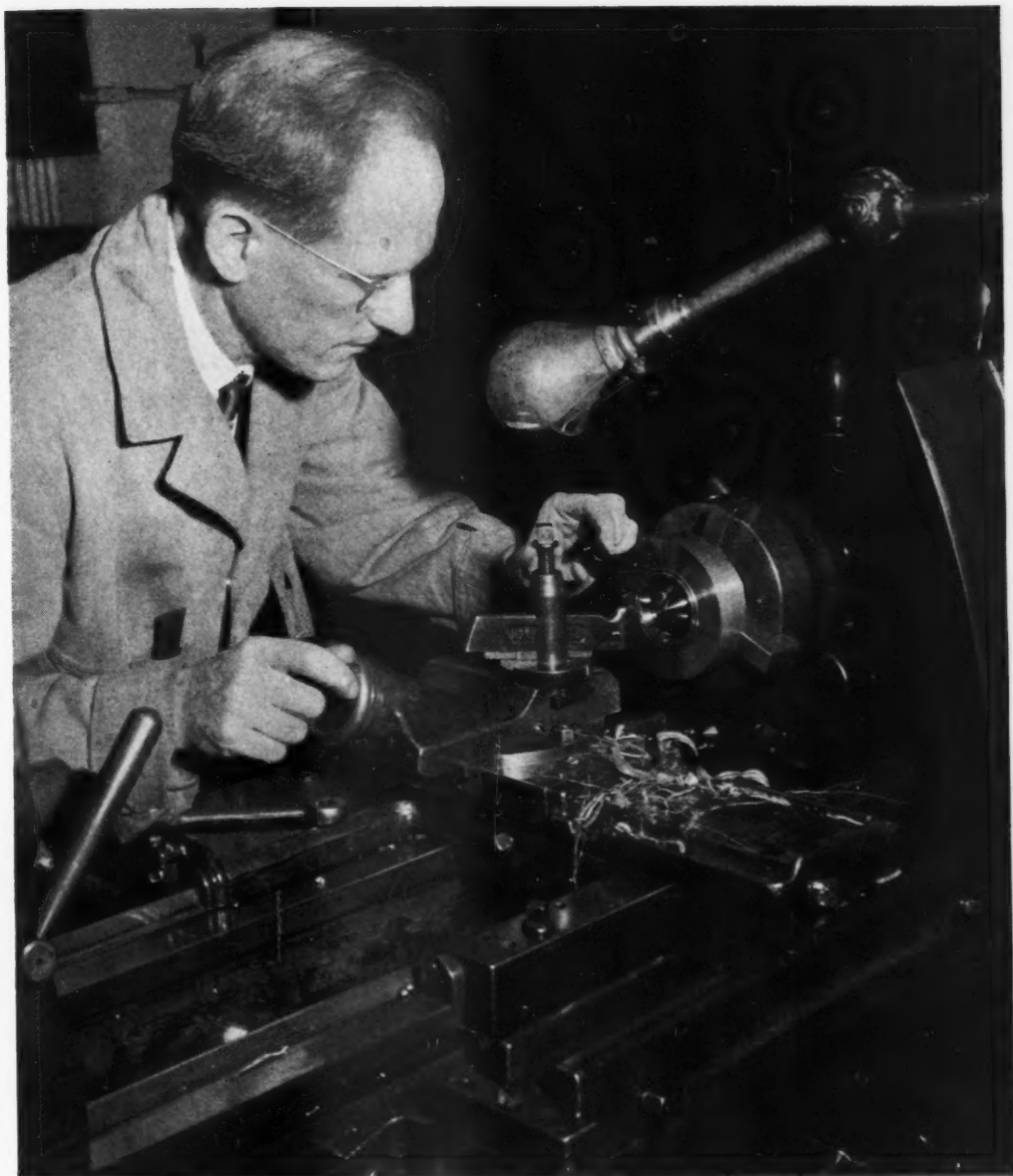


Fig. 3—Schematic of equipment for cable insulation tests

## NEWS AND PICTURES OF THE MONTH



*A die for molding diaphragms is being turned on a lathe in the Precision Shop*

## News of the Month

### STEREOPHONIC RECORDINGS AT ROCHESTER

STEREOPHONIC recording was demonstrated to a large and appreciative audience in the Eastman Theatre at Rochester on the evening of May seventh, following the presentation during the day of a series of papers by members of the Laboratories technically descriptive of the stereophonic system. The occasion was a joint meeting of the Acoustical Society of America and the Society of Motion Picture Engineers; it was attended also by more than two thousand members of the Rochester Civic Music Association.

After a brief welcome by Dr. Howard Hanson, Director of the Eastman School of Music of the University of Rochester, and introductions by F. R. Watson and Emery Huse, presidents respectively of the two societies, Harvey Fletcher gave a short demonstration of the directional and spatial effects which are described as "stereophonic" and introduced a recording of Paul Robeson in a scene from "The Emperor Jones." The audience followed with hushed attention Mr. Robeson's characteristic voice as it appeared to follow his changing position behind the curtain; when the recording ended a burst of applause indicated complete acceptance of the stereophonic illusion. Pitch range and naturalness of the system and its dynamic range were next demonstrated.

A high point of local interest and an extremely severe test of the potentialities of the system was presented through the co-operation of several talented students of the Eastman School of Music. The audience was given the opportunity of comparing musical selections as performed by the students with recordings of the same selections which had been made a couple of weeks earlier. So faithful were the recording and reproduction that the audience, when they were called upon to decide which was which, voted about fifty-fifty.

Following this complete demonstration of the capabilities of the system to reproduce all that the ear can perceive there were presented several enhanced recordings. The audience responded with great enthusiasm to the entire program of recordings, particularly the Tabernacle organ in "Westminster Chimes," to the selections from Elijah and to the recordings of the Philadelphia Orchestra which had been enhanced by Leopold Stokowski.

The demonstration itself was under the supervision of W. B. SNOW. R. BIDDULPH, A. B. ANDERSON and L. A. ELMER operated the reproducing equipment; A. R. SOFFEL and R. W. BUNTENBACH, the electrical system, and J. H. KRONMEYER, the loud speakers.

Technical papers presented during the convention on the stereophonic sound-film system included *General Principles* by HARVEY FLETCHER and E. C. WENTE; *Mechanical and Optical Equipment* by E. C. WENTE, R. BIDDULPH, L. A. ELMER and A. B. ANDERSON; *Pre- and Post-Equalization of Compandor Systems*, J. C. STEINBERG; *Electrical Equipment for the Stereophonic Sound-Film System* by W. B. SNOW and A. R. SOFFEL; *A Light Valve for the Stereophonic Sound-Film System* by E. C. WENTE and R. BIDDULPH; *Internally Damped Rollers*, E. C. WENTE and A. H. MULLER; and *A Non-Cinching Film Rewind Machine* by L. A. ELMER.

### THE TELEPHONE BUSINESS

CALLS TO THE NEW YORK Telephone Company's time bureau increased substantially during the three days of the week-end in which clocks were changed from Eastern Standard Time to Daylight Saving Time. Over the week-end of April 18, a normal one, approximately 127,000 calls were received while during the following week-end, when the time was changed, 163,000 were received.

Some 52,000 calls are received on an average business day at the telephone company's time bureau at 227 East 30th Street, Manhattan. This service was first established in 1928 and while at first confined to the city, it was later extended to various suburban communities. Seventy operators, whose usual duties are in the central office in the same building, are available for half-hour turns at the announcing assignment. The announcements are made at 15-second intervals all day and night. The time bureau equipment is so designed that the announcements can be heard by more than 800 callers at any one time.

There are other time-of-day services operated by the Bell System in Boston, Buffalo, Newark, Cleveland, Chicago, Los Angeles, San Francisco, Portland (Oregon), and Detroit, which in turn covers twelve Michigan cities from its bureau.

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LATEST DEFENSE CONTRACT FIGURES show that \$672,000-000 is being spent in Connecticut for vitally needed supplies. Each individual defense project has its own specialized telephone requirements that must be met by The Southern New England Telephone Company. The demands of all must be met and often many of them must be met at the same time. For the first three months of 1941, local calls increased 25 per cent above normal and out-of-exchange calls, 27 per cent. At the end of March there were nearly 10,000 more telephones than at the first of the year and it is estimated that by the end of the year the increase will be 37,000 or 61 per cent more than last year. It is expected that plant additions this year will amount to \$11,400,000 or nearly 70 per cent above normal. Of this, \$3,114,000 is for telephones and associated equipment and \$2,235,000 for dial-office equipment.

June 1941

## VAIL MEDAL AWARDS

THREE GOLD AND SEVEN SILVER MEDALS have been awarded by the National Committee of Award, Theodore N. Vail Medals, for acts of noteworthy public service performed by telephone men and women during 1940. Gold medals were awarded to:

FRANK ATKINSON, combination man of The Mountain States Telephone and Telegraph Company, Fort Morgan, Colorado, who, while attempting to restore telephone circuits on the Denver-Fort Morgan line during a blizzard, collapsed from exhaustion and was frozen to death. This was a posthumous award and was presented to his wife.

MRS. MILDRED LOTHROP, agency chief operator, Northwestern Bell Telephone Company. In 1920, Mrs. Lothrop performed noteworthy service during a flood at Homer,



*H. W. Herrington and L. M. Ilgenfritz of the Transmission Development Department working out a design problem in the "breadboard" stage*

Nebraska, for which she received the first Vail medal of gold. She now receives a second award for similar service in the same community, thereby becoming the only individual to receive two gold medals.

MRS. NELLE LAZURE, agent operator, Northeastern Telephone Company, Winnebago, Nebraska, for warning inhabitants of the town of oncoming flood waters despite great personal danger.

A silver medal was awarded to LUTHER ELBERT LAMB, combination man, Southern Bell Telephone and Telegraph Company, Winona, Mississippi, for the rescue of a light and power company employee who had been shocked unconscious by 13,000 volts while working on the top of a pole and whose clothing was ablaze.

Silver medals were also awarded to six employees of the New Jersey Bell Telephone Company—RUSSELL T. ANDRESS, WALTER N. BURT, ALTON G. COOK, THOMAS E. DONAHUE, ARTHUR J. SULLEY and SIDNEY

WALTON—for restoring telephone service immediately following the explosion and fire in the powder plant at Kenvil, New Jersey, on September 12, 1940.

Bronze plaques, in commemoration of these acts, were awarded to all of the telephone companies involved.

## UNITED STATES SAVINGS BONDS

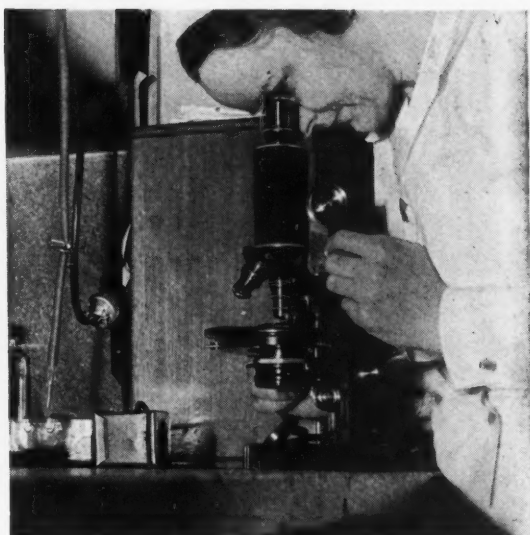
ADDITIONAL INVESTMENT OPPORTUNITIES in three new series of Defense Savings Bonds are available to members of the Laboratories through a revision of the Payroll Allotment Plan made on May 1. The change is occasioned by the Government's discontinuance of the so-called "Baby Bonds," and replacement with the new series E, F and G Defense Savings Bonds.

Series E bonds replace the former ones, but holders of these are now limited to \$5,000 maturity value issued in any one calendar year instead of \$10,000. Redemp-



*Accurate records are of fundamental importance to every individual who utilizes the Medical Department and to an analysis of the services it renders in the 1750 or so visits per month which are made to it. The medical records of each individual are strictly confidential and have the same status as the records between private physicians and patients.*

*A group is shown above conferring on a system of coding by the punch-card method to derive impersonal statistical data on the work of the Medical Department. Left to right around table are A. O. Jehle, G. A. Brodley, W. E. Marousek, J. S. Edwards and Dr. M. H. Manson*



*The clinical laboratory of the Medical Department aids diagnoses. Facilities are available for such procedures as blood counts, hemoglobin determinations, and urinalysis. The latter is a routine in all pre-employment and periodic health examinations; abnormalities it discloses may be the first indication of need of medical advice. Blood examinations are of utmost value in checking known or suspected anemia and various types of infection. The pictures show Miss Ella Good making a chemical test for sugar and Miss Helen Adams making a blood count*

tion values are slightly lower if redeemed within seven years, although the interest rate is the same (2.9 per cent) if held to maturity. All payroll allotment authorizations on file prior to May 1 were automatically carried over to apply to new Series E bonds unless otherwise notified.

Provision is also made for the purchase of Series F and G bonds. The Series F bond is offered for 74 per cent of its maturity value with maturity of twelve years. If held to maturity, the yield approximates 2.53 per cent per annum. The Series G bond is offered to meet the demand for a current income bond. It is issued at par and bears interest during its twelve-year term at  $2\frac{1}{2}$  per cent, paid semi-annually. These bonds may be redeemed, at less than par value, before maturity on thirty days' notice after six months from date of issue. Both Series F and G bonds may be purchased in denominations of \$100, \$500, \$1,000, \$5,000 and \$10,000. The plan does not provide for the purchase of Postal Savings Stamps.

#### COLLOQUIUM

AT THE APRIL 15 meeting of the Colloquium Dr. H. Mark of the Brooklyn Poly-  
June 1941

technic Institute, formerly of the University of Vienna, discussed *Elastic Properties of High Polymers*. He gave a statistical interpretation of the elastic behavior of long chain compounds, and described phase transitions of the first and second order in rubber and synthetic rubber.

*Atomic Power from Uranium* was the subject discussed by Dr. J. A. Wheeler of Princeton University at the April 21 meeting. Dr. Wheeler said that the discovery of nuclear fission in January, 1939, opened the way to development of a controllable source of atomic power. On absorbing a neutron, a uranium nucleus divides with the release of 200 million volts of energy as compared with the five volts released by the burning of an atom of carbon in coal. About three neutrons are liberated from the nucleus in the division process and provide a means of initiating fission in neighboring uranium nuclei. He outlined three proposed means of developing such a power-releasing chain reaction and reviewed the characteristic features and possibilities of uranium as a power source.

Dr. K. Lark-Horovitz of Purdue University spoke on *X-Ray Investigations of Liquids* at the May 5 meeting. Thermo-



*Fred Sindlinger of the Development Shop machining a bending tool in the new precision-type milling machine*

dynamic, kinetic and other considerations lead to the conclusion that liquids resemble crystals to a certain extent. X-ray diffraction methods applied to properly chosen material reveal the coördination and degree of order in a liquid. This was shown for the case of salts, argon, molecular fluids, glasses and amorphous bodies.

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J. W. BANCKER and W. F. HOSFORD, directors of the Laboratories, have been elected members of the Executive Committee of Western Electric Company.

MEMBERS OF THE LABORATORIES who have been granted leaves of absence to enter military service since the last issue of the RECORD are:

J. E. FOX, 11th Radio Intelligence Company, Signal Corps, Army Air Base, Augusta, Georgia.

T. B. JONES, 22nd Signal Company, Signal Corps, Fort Meade, Maryland.

T. J. SLATTERY, 187th Field Artillery, Fort Ethan Allen, Vermont.

JOHN NICHOL, Company A, 14th Training

Battalion, Infantry, Camp Wheeler, Macon, Georgia.

MICHAEL COLLINS, F. N. HODGE, C. J. KUHN and C. E. MERKEL have left for military service but their addresses have not been received as yet.

T. E. SHEA, engineering vice president of Electrical Research Products Inc. and formerly a member of the Laboratories, has been granted an indefinite leave of absence to participate in important studies for the National Defense Research Committee.

THE PHONOGRAPH RECORD that has been available for public demonstration of the tones used in dial offices has been revised to include the new "no-such-number" tone described in the April issue of BELL LABORATORIES RECORD. The new record (Western Electric B.T.L. 5790) is ten inches in diameter and covers dial tone, ringing induction, 60 I.P.M. busy signal, 120 I.P.M.

busy signal, the present standard no-such-number tone, and the future standard no-such-number tone.

MEMBERS OF THE LABORATORIES to whom collegiate degrees were awarded during the past months include:

Arthur Berger	B.Ch.E.	N.Y.U.
J. R. Brady	B.E.E.	N.Y.U.
P. J. Keenan	B.A.	C.C.N.Y.
W. J. Myles	B.S. in Chem.	C.C.N.Y.
G. H. Somerville	B.E.E.	N.Y.U.
S. D. Robertson	Ph.D.	Ohio State
E. C. Weiss	B.C.S.	N.Y.U.

PAPERS PRESENTED at the Washington meeting of the American Physical Society were *The Structure of Black Carbon* by A. H. WHITE and L. H. GERMER; *Magnetic Domain Size Determined from Measurements of Damping in 68 Permalloy* by H. J. WILLIAMS and R. M. BOZORTH; and *The Thermal Expansion of Pure Metals: Iron, Nickel, Copper, Gold and Aluminum* by F. C. NIX and D. MACNAIR. Others attending the meetings, which were held from May 1 to 3, included A. J. AHEARN, J. A.

BECKER, W. H. BRATTAIN, J. A. BURTON, K. K. DARROW, F. S. GOUCHER, R. O. GRISDALE, H. E. IVES and J. N. SHIVE.

G. R. STIBITZ, before the Junior Mathematical Club of Hunter College in New York City on May 6, discussed the theory and operation of the complex number calculator developed in the Laboratories.

R. M. BOZORTH spoke on *The Physical Basis of Ferromagnetism* before the Physics Colloquium at the Randal Morgan Laboratory of Physics of the University of Pennsylvania on May 7 at Philadelphia and before a meeting of the Philosophical Society of Washington on May 10. He also visited the Navy Yard in Washington on May 1 and 10.

R. M. BURNS, at a meeting of the American Society for Metals that was held in Philadelphia on April 25, presented a paper on *Prevention of Corrosion of Metals*.

M. D. RIGTERINK attended the annual meeting of the American Ceramic Society held at Baltimore on April 1 and 2.

J. M. FINCH, on April 25 at Springfield, Massachusetts, attended an A.S.T.M. committee meeting devoted to a discussion of paper-testing methods. While in Springfield, Mr. Finch, with D. A. McLEAN, also discussed problems concerning the chemistry of insulating papers with engineers of the Smith Paper Company.

G. T. KOHMAN and W. E. CAMPBELL inspected an air-conditioning unit being operated in the Widener Memorial Library at Harvard University for the preservation of rare volumes and arranged to check its protective action against surface film formation on metals.

J. R. C. BROWN, JR., at the Biennial Career and College Night of Richmond High School in Queens, New York, discussed informally research in chemistry.

R. M. BURNS, R. B. GIBNEY, K. G. COMPTON and H. E. HARING attended the Electro-Chemical Society's convention that

was held in Cleveland from April 17 to 19.

E. C. LARSEN attended meetings of the American Chemical Society held in St. Louis from April 7 to 11.

DURING APRIL, B. H. JACKSON, E. B. CAVE, G. C. LORD and H. S. WERTZ were at the Patent Office in Washington relative to patent matters.

E. F. KINGSBURY attended the Glossary Committee meeting of the Optical Society of America held in Washington.

H. E. IVES attended the American Philosophical meeting at Philadelphia and meetings of the National Academy of Sciences



*S. King observing meters through the glass window of a high-voltage protective enclosure in one of the transmission development laboratories in the Graybar-Varick building. The switch handle and lock in the upper left corner of the picture are mechanically interlinked so that the key must be in the lock before the switch can be turned on, and cannot be removed from the lock until the switch has been turned off. A gate on another side of the enclosure must be unlocked with this same key in order to enter. The electrical circuit is such that the gate must be closed and the switch turned on in order to connect power to the equipment inside the cage*

and the American Philosophical Society at Washington. Dr. Ives has been elected one of the Councillors of the American Philosophical Society for the three years 1941-1944.

E. T. MOTTRAM spoke on *Some Problems of Recording and Reproducing* at the last meeting of the current season of the Radio



*A. F. Bennett (center) discussing the manufacture of plastic molded telephone sets at the Hawthorne Works of the Western Electric Company with H. E. Mali (left) and W. J. Malcolmson (right)*

Colloquium held on May 9 at the Holmdel Radio Laboratory. Officers elected for the coming year are K. G. JANSKY, president; C. F. ROSE, chairman of the program committee; and A. G. FOX, secretary.

J. F. MORRISON and A. A. SKENE attended the annual convention of the National Association of Broadcasters held in St. Louis from May 12 to 15.

AT THE WESTERN ELECTRIC COMPANY in Hawthorne, K. G. COMPTON discussed plating processes; N. BOTSFORD, development of coils; J. E. SHAFER and H. M. STOLLER, new designs of line and cut-off relays; C. N. HICKMAN, A. C. KELLER and L. H. JOHNSON, switching development problems; T. S. HUXHAM and W. ORVIS, molding designs and processes; T. C. CAMPBELL, the manufacture of rolling ladders; and H. A. MILOCHE, crossbar equipment problems.

J. G. FERGUSON attended an A.I.E.E. subcommittee meeting of the Instruments and Measurements Committee at which accurate classification of measurements was the subject for discussion.

R. W. DEMONTE has been elected Chairman of the Basic Science Group of the New

York section of the A.I.E.E. for the year 1941-42.

C. A. WEBBER, R. T. STAPLES, H. H. STAEBNER and V. H. HEITZMANN visited Point Breeze to discuss cord development problems.

MR. WEBBER and D. R. BROBST visited the Anaconda Wire and Cable Company and the Habirshaw Cable Wire Corporation plants in connection with problems relating to wire development.

J. H. BOWER visited Washington recently to discuss dry batteries with Dr. G. E. Vinal of the National Bureau of Standards.

F. CAROSELLI spoke on *The General Requirements of an Electrical Engineer* before the Parents and Students Guidance Session at the Dickinson High School in Jersey City.

C. ERLAND NELSON was in

Pittsburgh in connection with contact studies of panel-bank apparatus.

A. H. YEAGER and H. W. PURCELL visited the Waverly Office of The Bell Telephone Company of Pennsylvania in Philadelphia on contact noise studies.

AT THE KEARNY PLANT of the Western Electric Company, J. S. GARVIN and J. E. SHAFER discussed the introduction to manufacture of the 267A relay and G. B. BAKER, step-by-step relay problems.

J. R. TOWNSEND attended a meeting of the special research committee on mechanical springs of the American Society of Mechanical Engineers; presided at a meeting of the American Standards Association's sub-committee on standardization of wire gages; and attended the open conference on replacement materials sponsored by the Philadelphia District Committee of the American Society for Testing Materials.

R. BURNS has been appointed Chairman of a Special Research Committee on Industrial Flow Tests recently organized by the American Society for Testing Materials.

ON APRIL 17 and 18 R. A. DELLER, with representatives of other Bell System companies, visited the Massachusetts Institute

of Technology, to interview applicants for the Communications Option of the cooperative course offered at the Institute.

F. HARDY was at the New Canaan, Connecticut, office of The Southern New England Telephone Company to observe lubricating methods on step-by-step switches.

C. H. WHEELER was at the Manhattan Rubber Company, Passaic, New Jersey, to discuss the manufacture of parts for water-filled fire extinguishers.

N. J. EICH was in the Bayonne office of the New Jersey Telephone Company in connection with a study of line relays.

E. W. GENT visited The Bell Telephone Company of Pennsylvania at Allentown in connection with a study of pneumatic ticket distributing systems.

R. V. TERRY made a trip to the Haydon Manufacturing Company at Forestville, Connecticut, to discuss timing apparatus.



*Victor Chirba measuring the d-c resistance of a 106-type resistance in the coil-test room of the Development Shop*

G. G. SMITH visited the J. S. Popper Company in Union City, New Jersey, in regard to air displacement studies of exhausters.

R. A. HAISLIP and W. E. MOUGEY discussed cable design matters with engineers at Point Breeze.

C. H. AMADON and A. H. HEARN recently inspected an installation of experimental

poles at Philadelphia. Mr. Hearn also visited Nashua, New Hampshire, Montreal and Toronto on matters pertaining to the treatment of red-pine poles.

L. M. GAMBRILL was in Washington to observe electrical tests on the coaxial circuits of the Baltimore-Washington cable.



*D. H. King indicating changes in the die for molding the combined telephone set housing. The form shown is a plaster-of-paris cast to illustrate the alterations*

C. C. LAWSON visited Knoxville and the Point Breeze plant of the Western Electric Company on wire-development problems.

H. BAILLARD, in the territory of The Diamond State Telephone Company, inspected the application of a new type of splice protection for buried cable.

AN ARTICLE ENTITLED *A New Microphone Providing Uniform Directivity Over an Extended Frequency Range*, by R. N. MARSHALL, formerly of the Laboratories and now with the Western Electric Company, and W. R. HARRY, was published in the April issue of *The Journal of the Acoustical Society of America*.

R. G. KOONTZ, together with engineers of the A. T. & T. and the Western Electric, discussed crossbar additions that are being



*George Wolff of the Physical Research Department assembling an electron gun for a large cathode-ray tube*

made at Detroit with engineers of the Michigan Bell Telephone Company.

J. T. MOTTER visited the Jonesville office of the New York Company to investigate unattended community dial equipment.

THE INSTALLATION of a No. 355 dial office with a No. 3-CF toll switchboard at Millbrook, New York, was inspected by R. L. LUNS福德, W. G. SCHAEER, S. J. BRYMER, D. C. MEYER, H. O. SIEGMUND and J. J. KUHN.

J. SHEA and C. S. KNOWLTON recently visited Cleveland to discuss with Long Lines engineers the installation of a teletypewriter system for the Republic Steel Corporation.

MR. SHEA also visited Schenectady and

Albany on April 15 and 16 to discuss, with representatives of the General Electric Company, the Long Lines Department and the New York Telephone Company, an addition to the present teletypewriter system recently installed in the General Electric Company plant at Schenectady.

B. C. BELLows, JR., and J. F. POLHEMUS visited Philadelphia in connection with the installation of equipment on the coaxial cable system. Mr. Bellows was also in Princeton on the same project.

J. W. WOODARD visited Hawthorne and Detroit to discuss current switchboard orders.

D. C. MEYER and H. A. AFFEL discussed cable-carrier projects with representatives of the Northern Electric Company at Montreal.

V. T. CALLAHAN and C. W. VAN DUYNE were in East Pittsburgh and Canton testing gasoline-engine sets. Mr. Callahan was also in Kansas City and Mattoon (Illinois) discussing Diesel engine-generator sets.

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DURING THE MONTH of April two members of the Laboratories retired—MISS MAY QUINN of the General Service

Department on April 9 with thirty-three years of service and BRUCE FREILE of the Switching Apparatus Development Department on April 8 with thirty-two years of service.

Miss Quinn joined the New York Telephone Company in 1908 and four years later transferred on a temporary basis to the American Telephone and Telegraph Company to supervise a group of girls working on rate charts. When this work was completed she permanently joined the chief clerk's office of the Engineering Department on general clerical work and in charge of miscellaneous services. She continued this type of work with the Department of De-

velopment and Research when this was formed in 1919. Since 1934, when the D & R was consolidated with the Laboratories, she has been in charge of the messenger service group located on the sixth floor.

After Mr. Freile received his M.E. degree from Stevens Institute of Technology in 1909, he worked for a short time for the Crocker-Wheeler Company and then came to West Street to take charge of the physical division of the shops' laboratory and later headed the chemical and check inspection work. When manufacturing activities removed to Hawthorne he left the company but returned in 1914 to design dial apparatus with the Engineering Department and was associated with the work on pulse machines, reciprocating bar-type interrupters, number-checking units and associated apparatus used in the panel-dial system.

Shortly after the manufacturing organization of the Western Electric Company undertook the manufacture of step-by-step apparatus in 1926, Mr. Freile was placed in charge of a group handling the general engineering problems and apparatus development project of this apparatus. These included the development of the present phenol-fibre step-by-step bank, the present switch-shaft restoring mechanism, and other im-



MISS MAY QUINN



BRUCE FREILE

provements sponsored by the Laboratories. An excellent designer in his own right, Mr. Freile's most important contributions related to apparatus for the crossbar switching system. The apparatus development work on crossbar switches, multi-contact relays, and associated cross-connecting apparatus, was carried out directly under his supervision and the currently used apparatus embodies numerous evidences of his own contributions. His knowledge of manufacturing tools and methods and his long experience with the manufacturing organization of the Western Electric Company have left their mark prominently impressed upon apparatus designed under his direction, and his devotion to his work and to those with whom he was associated will not soon be forgotten.

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DURING THE MONTH OF APRIL PATENTS WERE ISSUED TO THE FOLLOWING  
MEMBERS OF THE LABORATORIES

H. L. Barney	V. M. Cousins	D. H. King	A. E. Melhose (2)
J. F. Barry	G. C. Cummings	G. V. King	P. B. Murphy
J. A. Becker (2)	A. M. Curtis	F. S. Kinkead	O. Myers
U. S. Berger	W. A. Depp	H. K. Krist	D. B. Penick
B. G. Bjornson	H. W. Dudley	E. Lakatos	F. W. Reynolds
W. H. Brattain	R. C. Edson	F. B. Llewellyn	R. O. Rippere
E. Bruce	E. B. Ferrell	G. A. Locke	L. Schott
O. Cesareo	E. C. Hagemann	G. H. Lovell	O. A. Shann
J. G. Chaffee	C. N. Hickman	A. A. Lundstrom	E. G. Shower
J. W. Clark	W. H. T. Holden	W. P. Mason	A. Weaver
H. R. Clarke	F. A. Hoyt	R. C. Mathes	J. W. West
I. E. Cole			I. G. Wilson



F. S. MAYER



A. C. GILMORE



W. L. BETTS

### TWENTY-FIVE-YEAR SERVICE ANNIVERSARIES

SHORTLY AFTER ENTERING the Western Electric Company F. S. MAYER spent about two years with the Standards Division of the Engineering Department maintaining and calibrating transmitter and receiver standards. During this period the first World War broke out and he assisted also in the assembly and testing of transmitters used in submarine detection. For a short period after he engaged in fundamental transmitter studies and then became associated with the current engineering group. Here he was concerned with engineering problems on carbon transmitters, particularly on testing methods and inspection of granular carbon and electrodes. During the latter period he assisted in the introduction of the manufacture of granular carbon roasted by the electrical method which was developed in conjunction with the handset transmitter and is used for producing all granular carbon at present. Also, he took part in the work of changing the testing method from a test of the complete transmitter to a much more simplified and accurate cell test.

For the past two years, in the Station Apparatus Development Department, Mr. Mayer has been associated with the development of testing methods and inspection of plastic materials for handsets and tele-

phone housings. He is a member of The Telephone Pioneers of America and lives in Jackson Heights, Long Island.

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MOST OF A. C. GILMORE's service with the Laboratories has been in the Equipment Development Department of the Systems Development organization. After a brief period on materials inspection he transferred to equipment drafting and then, in 1923, became concerned with the analyzation of Hawthorne orders and later with trial installations. Since then he has been engaged in the development of equipment for central offices, the more important of which have been the Nos. 11 and 12 switchboards and the Telephone Weather Bureau. In addition he has been associated with many other projects such as the holding time recorder, traffic register equipment for the new toll-crossbar system, operators' training equipment and information desks.

Mr. Gilmore, who lives in Lyndhurst, New Jersey, has two boys in Stevens Institute of Technology and a daughter eleven years old. He has just begun a second three-year term on the Lyndhurst Board of Education and belongs to the Edward J. Hall Chapter of The Telephone Pioneers.

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W. L. BETTS received the degree of M.E. from the Polytechnic Institute of Brooklyn in 1915, and after a year with the Remington Arms Company joined the Research Depart-

ment of the Western Electric. His early work was on telephone repeaters but during the first World War he assisted in the development of submarine detectors, and later, carrier-telephone and telegraph apparatus. From 1921 to 1937 he was a supervisor of various groups in the Commercial Products Development Department where he was successively engaged in work on carrier apparatus, rheostats, potentiometers, vacuum tubes and special products, such as sound picture and public address systems, hearing aids, audiometers and special apparatus for the Signal Corps and U. S. Navy.

Since 1937 Mr. Betts has been concerned with the repair of station apparatus and has also been the point of contact with the Underwriters Laboratories in connection with getting approval on such apparatus manufactured by the Western Electric Company as requires this approval. He has been chairman of the photographic group of the Metropolitan section of the A.S.M.E. for the past two years and is a member of the Board of Directors of Brooklyn Polytechnic Alumni Association and a member of The Telephone Pioneers. The Betts live in Brooklyn with their two children and spend their summers at Old Greenwich, Connecticut.

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H. B. JOHNSON attended Amherst for two years and then went to Columbia where he received his B.S. degree in 1914. After taking post-graduate work at Columbia he

joined the apparatus design group of the Engineering Department of the Western Electric Company. He served in the first World War from 1917 to 1919, first with the 319th Field Signal Battalion and, after receiving his commission, was in France with the radio section of the Signal Corps. Upon his return and for the next five years he was with the relay design group. Since then, in the Switching Development Department, he has been associated with the design of numerous manual circuits including the design of circuits for straightforward trunking, operating-room desks, information desks, and various other apparatus.

Mr. Johnson, who lives in New York City, is a charter member of the Western Electric Post of the American Legion and a member of the Columbia University Club.

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FOLLOWING THREE YEARS with the Electrical Testing Laboratories, R. J. HOPF came to the Engineering Department at the time that much work was being done on the development of printing telegraphs and for five years he assisted in the testing of this equipment. Immediately upon joining the Bell System he entered Cooper Union, receiving a B.S. in E.E. degree in 1921, and then, following additional courses at Columbia and Cooper Union, received an E.E. degree from the latter in 1936.

In 1921 Mr. Hopf transferred to what is now the laboratories of the Switching De-



H. B. JOHNSON



R. J. HOPF



HOWARD KREFT



V. B. PIKE



F. A. MUCCIO

velopment Department where he has since been associated successively with methods of operation of central-office circuits; relay design work; testing of circuits for step-by-step systems; and most recently, in the toll laboratory group, with the testing of step-by-step intertoll dialing and crossbar toll dialing systems. Mr. Hopf, a Telephone Pioneer, has been a member of the Laboratories Bowling Club for the past seven years and is a golf enthusiast. The Hopfs have one child and live in Yonkers.

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ANOTHER MEMBER of the Laboratories who started in the telegraph printer group was HOWARD KREFT. His previous five-year experience with adding machines and typewriters was the foundation for his drafting design work in the group. In 1924 he transferred to the equipment section of the Systems Department on general drafting work on central-office equipment; and five years later was placed in charge of the Outside Plant drafting group in the Maltz building. When the Outside Plant Department returned to West Street in 1934, Mr. Kreft became associated with the general drafting group of the Apparatus Development Department where he performed drafting and checking work on apparatus drawings until recently when he transferred to the Commercial Products Development Department for a special assignment.

Mr. Kreft's wife is the former Carolyn

Roeder who worked for Western Electric Engineering Department over twenty years ago. They live in Cliffside Park, New Jersey, and have one daughter who is just finishing her sophomore year at the Montclair State Teachers College.

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DURING THE time that V. B. PIKE was obtaining his education he worked for four summers with the Western Electric Installation Department and one with The Bell Telephone Company of Pennsylvania. Upon receiving his E.E. de-

gree from Lehigh in 1917 he returned to the latter and until 1926 was with their Outside Plant Engineering Department dealing with the general problems of the erection and installation of all types of cables. During this time he originated the use of dry nitrogen gas in the maintenance and testing of lead-covered cables. A continuation of this type of work took him to the D & R in 1926 and to the Laboratories shortly thereafter upon the organization of the Outside Plant Development Department. Since that time he has worked on problems of cable splicing and has carried on the development of the maintenance of cables by gas pressure. One of his most recent developments is the "CR" tape used for the temporary protection of splices in lead-covered cables during the construction period and, more recently, in the repair of cables where the sheath has failed due to fatigue. An article by Mr. Pike on this tape is scheduled to appear shortly in the RECORD.

During the first World War, Mr. Pike was a Radio Officer in the Air Service for thirteen months. He was at first assigned to Kelly Field in San Antonio, Texas, in charge of radio instruction for pilots in training and later was responsible for the same type of work at Langley Field, Virginia. Mr. Pike, who is a Telephone Pioneer, lives in Morristown, New Jersey, and has a son in high school. His moments of relaxation are spent

in metal working in an unusually well-equipped workroom in his home.

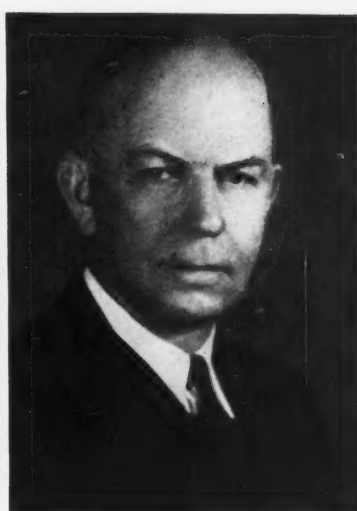
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F. A. MUCCIO entered the Transmission Branch of the Western Electric Engineering Department in 1916 and was associated with transmission testing and analysis of subset instruments until 1924. During this time he attended Cooper Union from which he received a B.S. in E.E. degree in 1921. He also took one year of post-graduate work at Columbia. In 1924 and 1925 he was engaged in the computation of transmission losses in voice-telephone circuits under various operating conditions. Since then Mr. Muccio has been with the carrier telephone group of the Transmission Development Department where he has been concerned with the development of carrier telephone terminals and related circuits.

During the first World War, Mr. Muccio



C. W. KECKLER  
*of the Switching Development Department completed thirty years of service in the Bell System on May 15*



E. D. JOHNSON  
*of the Switching Development Department completed thirty-five years of service in the Bell System on May 28*

was at Port Washington, Long Island, in connection with the development of submarine detectors. He lives in Dobbs Ferry, New York, near the Ardsley Country Club, and for many years has been interested in outdoor sports, particularly water sports such as swimming and boating. He is also a member of the Edward J. Hall Chapter, Telephone Pioneers of America.

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F. T. FORSTER, at Roanoke, observed the condition of storage batteries which have been operating under test for several years.

R. P. JUTSON is at Eau Claire, Wisconsin, on the Minneapolis-Stevens Point coaxial project.

A. E. PETRIE, at Washington, discussed engine problems with engineers of The Chesapeake and Potomac Telephone Company.

J. H. SOLE was in Cleveland on machine and regulator design problems.

H. H. SPENCER visited



M. A. FROBERG  
*of the Equipment Development Department completed twenty-five years of service in the Bell System on April 10*

June 1941



B. C. BELLOWES  
*of the Switching Engineering Department completed thirty-five years of service in the Bell System on May 3*



*Testing the testing equipment. W. Miller and W. F. Sefcik are shown at the test bays in the test equipment maintenance room on the tenth floor of the Graybar-Varick building. The test bays are used in checking the accuracy of laboratory measuring equipment*

engine installations for the radio telephone equipment at Crisfield, and at Smith and Tangier Islands.

BECAUSE OF THE INSTALLATION of new crossbar offices, E. W. HANCOCK spent half the month of April in Pittsburgh and the other half in Chicago; W. I. McCULLAGH spent the month in Pittsburgh; and C. H. McCANDLESS and O. H. WILLIFORD were in St. Louis for several days. Mr. Williford also visited Baltimore.

G. A. HURST spent a week in Atlanta making tests of the panel incoming-selector circuit that is arranged for inward service from a step-by-step central office.

W. J. SCULLY spent several days in Chicago in connection with the cutover of the South Chicago Office.

L. H. JOHNSON attended the April 30 session of the North-

eastern District convention of the American Institute of Electrical Engineers.

A. A. HEBERLEIN, at Washington, engaged in tests concerned with the vacuum tubes used in type-K systems and in program transmission circuits.

H. M. TRUEBLOOD, A. H. SCHIRMER, L. S. INSKIP and E. D. SUNDE were in Pittsfield to discuss lightning protection problems with Dr. K. B. McEachron of the General Electric Company.

L. S. INSKIP, accompanied by T. J. Maitland of the Long Lines Engineering Department, was in Eau Claire, Wisconsin, investigating lightning problems on toll cables.

L. Y. LACY was in Newark, South Orange and Summit testing noise and crosstalk on special circuits between New York and Murray Hill.



*Martin Kastner boring a casting on a milling machine in the Development Shop. This casting is for a glass-sealing machine that will be used in the Tube Development Shop*

R. M. HAWEKOTTE on April 25, in coöperation with representatives of the Rural Electrification Administration, made wave-shape tests on new Diesel alternator sets at the International Diesel Electric Company plant in Long Island City.

C. C. CASH, C. H. GORMAN, JR., B. C. GRIFFITH, W. E. REID, E. S. WILCOX, and A. L. WHITMAN have been in St. Louis, Kansas City, and Joplin, Missouri, in connection with cable-carrier crosstalk tests.

THE TELEVISION EXPERIMENTS on the Stevens Point-Minneapolis coaxial cable

described on page 315 of this issue were carried on under the supervision of J. F. WENTZ. The Laboratories' engineers working under C. L. WEIS who set up the television demonstration apparatus were J. R. BRADY, J. J. JANSEN, W. R. LUNDY, L. W. MORRISON, J. P. RADCLIFF and R. J. SHANK. The coaxial circuit, which is being prepared for commercial telephone service, was specially lined up for the television demonstration by H. H. BENNING, B. DYSART, C. C. FLEMING, and K. E. GOULD reporting to K. C. BLACK. In addition to a

*The Table Tennis Club of the Bell Laboratories Club consists of one hundred and fifty active members. Players compete daily at noon hour in a continuous ladder and throughout the season in Round Robin Leagues and many tournaments. In addition to this activity, three men's and one women's team participate in outside competition. F. J. Saxton is chairman and H. L. Lofsgaard, secretary.*

*The photographs show H. L. Holley and J. V. Elliott, Doubles Champions for the past three years; T. J. Doherty, Men's Singles Champion for the 1939-1940 and 1940-1941 seasons; and Marjory Tulloch, Women's Singles Champion, 1940-1941*



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G. C. CUMMINGS, 1877-1941

F. S. IRVINE, 1882-1941

W. B. WELLS, 1884-1941

large number from the Northwestern Bell Telephone Company, the demonstrations were witnessed by A. B. CLARK, M. E. STRIEBY, now of Long Lines, PIERRE MERTZ, and the Chicago and Omaha field engineers, H. M. CRAIG and W. T. JERVEY, respectively.

S. ROSEN was at Eau Claire testing modifications of the automatic coaxial switching circuit preparatory to placing the coaxial system in service.

\* \* \* \* \*

G. C. CUMMINGS of the telegraph development group of the Switching Engineering Department died on April 25. Mr. Cummings completed twenty-five years of service last February; a complete biography of his work with the Laboratories and with various railroad companies before joining the Bell System was published in the March, 1941, issue of the RECORD.

\* \* \* \* \*

F. S. IRVINE, a member of the Switching Development Department with over thirty-four years of service in the Bell System, died on May 14. Mr. Irvine started his career in the telephone industry as a circuit draftsman in the Clinton Street shops of the Western Electric Company and soon assumed charge of this work. In 1912 he came to New York to work on machine switching systems which were then in their infancy. Since that time his activities have been devoted chiefly to the development of the panel system. He was a member of the

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small group who worked on the initial development of the semi-mechanical switching system and, as a supervisor, was closely associated with the installations at the Mulberry and Waverly offices in Newark and the Wilmington installation which followed shortly after. Following this he supervised the testing of all panel offices installed in New York City.

His extensive experience in installation and testing resulted in his appointment as supervisor in the methods and results group of the Local Central Office Development Department in 1923. He was responsible for installation methods and aided the men in the field in various engineering and technical difficulties as they arose. For the past several years he had been engaged in the development and design of panel circuits.

\* \* \* \* \*

W. B. WELLS of the Patent Department died on May 14. He had been with the Laboratories since 1926 and had specialized in handling patent matters pertaining to the regulation and control phases of communication equipment such as the control of generators and rectifiers for constant voltage or current, speed control for motors used in sound recording and reproducing systems, and the regulation in the gain or amplification involved in long transmission systems both by wire and by radio.

Mr. Wells received an M.E. degree from Cornell University in 1907 and an LL.B.

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degree from Georgetown Law School in 1913, at which time he was admitted to the Bar of the District of Columbia. He was with the United States Patent Office in Washington from 1910 to 1915 and then continued patent work with the Westinghouse Electric and Manufacturing Company until 1920. From then until he joined the Laboratories in 1926 he was with the Niles Bement Pond Company, A. F. Nathan and the American Car and Foundry Company.

\* \* \* \* \*

M. E. SEAGER, a former member of the Apparatus Development Department who retired in 1938 after twenty-six years of service, died on May 11. For seven years before joining the Bell System, Mr. Seager was a draftsman with Yale and Towne at Stamford and the Singer Sewing Machine Company at Elizabethport. In 1921 he joined the Engineering Department of the Western Electric Company where he was concerned with the mechanical design of telephone apparatus. Later he worked on special testing machines among which were those for testing the speed of telephone dials and for testing the strength of vacuum-tube filaments. He was also associated in the design of many of the mechanical details of sound-picture apparatus. In 1934 he transferred to the Commercial Products drafting group where he engaged in the layout and design of various commercial products. Returning to the Apparatus Development Department in 1937 he was concerned, until his retirement, with the design of equipment for testing metallic materials.

\* \* \*

W. H. AMBLER, a former member of the Apparatus Development Department who retired in 1936 after twenty-one years of service, died on April 28. Mr. Ambler was graduated from the University of Pennsylvania in 1902 with a B.S. degree in Electrical Engineering. He joined the Engineering Department of the Western Electric Company in 1913 and for three

years was with the apparatus drafting group. He left the company in 1916 and then returned to the same group two years later. He transferred to the Specifications Department in 1922 where he prepared manufacturing information, particularly on the apparatus developed by the Commercial Products Department. From 1928 until the time he retired in 1936 he was with the Commercial Products Development Department responsible for the mechanical design of various apparatus including all types of mountings.

\* \* \* \* \*

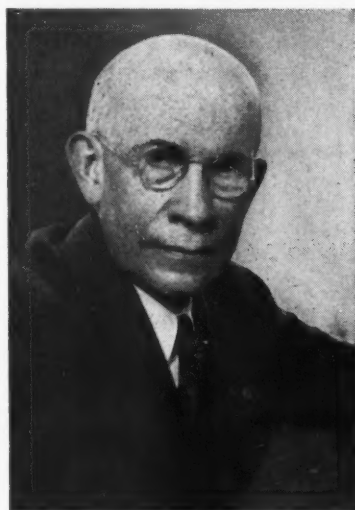
J. MALLETT and Miss E. RENTROP are measuring atmospheric noise in small cables on the Norfolk-Richmond route.

M. W. BALDWIN, JR., spoke on *The Subjective Sharpness of Simulated Television Images* before the annual convention of the Society of Motion Picture Engineers held in Rochester from May 5 to 8.

F. J. HERR, A. E. GERBORE, B. C. MEYER and J. H. MULLIGAN, JR., attended the 15th annual student branch convention of the A.I.E.E. held on April 24 at Rutgers University, New Brunswick, New Jersey.

G. B. ENGELHARDT and A. F. POMEROY were at Princeton investigating the effect of temperature on coaxial cables.

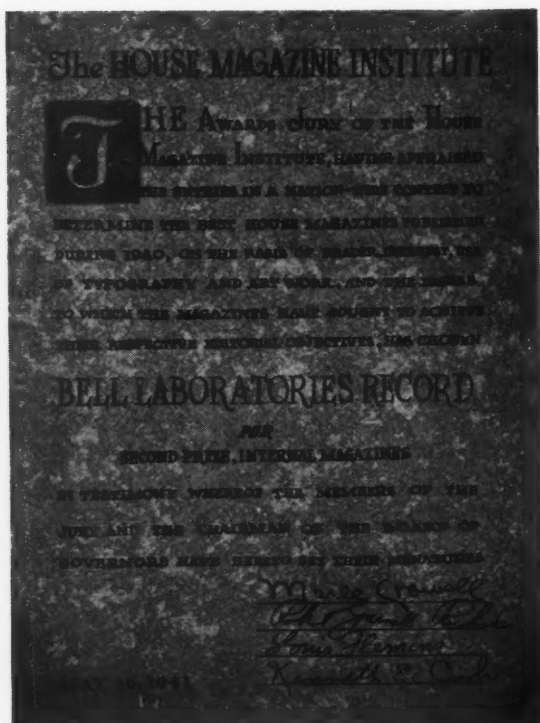
J. J. GILBERT, Q. E. GREENWOOD, H. B. BREHM and D. F. CUNEO in Rhode Island, on April 28 and 29, tested the Point Judith and Block Island cable.



M. E. SEAGER, 1876-1941



W. H. AMBLER, 1878-1941



*This certificate was awarded by the House Magazine Institute in a competition entered by some two-score outstanding magazines*

THE LABORATORIES were represented in interference proceedings at the Patent Office by A. J. ZERBARINI before the Board of Appeals, and by R. J. GUENTHER before the Primary Examiner.

P. C. JONES was the author of an article entitled *Idealism and Its Relation to Science* published in the April issue of the quarterly *Philosophy of Science*.

THE DINNER held in conjunction with the Twelfth Annual Safety Convention and Exposition of the Greater New York Safety Council was attended by L. E. COON, H. E. CROSBY, J. S. EDWARDS, H. B. ELY, J. R. P. GOLLER, L. S. HULIN, DR. M. H. MANSON, G. RUPP, G. B. THOMAS and W. A. TRACY.

*Effective with the July issue all the distribution of BELL LABORATORIES RECORD will be made by mail directly from its printer in Philadelphia. Members of the Laboratories will receive their copies at their home addresses, except in those cases where an individual prefers to receive it at the Laboratories; in that case he should send notification in writing to G. F. Fowler, Circulation Manager, Room 1102, 463 West Street*

THE MUSEUM OF SCIENCE and Industry in Chicago where some of the exhibit equipment of the 1933 exposition at Chicago and the 1939-40 in New York is being set up by the Illinois Bell Telephone Company took JOHN MILLS to Chicago during April. From Chicago he went to Minneapolis to discuss with the Northwestern Bell Telephone Company publicity matters in connection with the tests on the coaxial cable. On his return trip he visited the National Academy of Science Museum in Washington where the Laboratories for years has maintained a telephone exhibit on behalf of the Bell System. The latest addition to that exhibit, in the form of a voice mirror, has just been installed. F. L. HUNT was in Washington from April 25 to 28 supervising the installation of this voice mirror.

R. LINSLEY SHEPHERD attended the awards dinner of the House Magazine Institute and accepted, on behalf of the RECORD staff, the certificate shown on this page.

ARTHUR THOMPSON of the Bureau of Publication was recently elected president of the American Institute of Graphic Arts, a national organization devoted to the "stimulation and encouragement of those engaged in the graphic arts," and particularly to the improvement of artistic standards in printing and engraving. Mr. Thompson has been active in the Institute for a number of years as an officer and director and as chairman of the Textbook Clinic, and has written extensively for trade magazines in the publishing and advertising fields. As a member of the Bureau of Publication since 1925, he has been responsible for the design and printing of a large part of the Laboratories' publications since its organization, and has coöperated in planning a number of publications for the American Telephone and Telegraph and Western Electric Companies. Several of his designs have been included in exhibitions of fine printing by the Institute.





# Conical Mandrel for Testing Organic Finishes

By H. G. ARLT  
*Chemical Laboratories*

FOR many years, fingernail or penknife has been used to test the relative toughness, hardness and adherence of organic finishes. It has also been customary to bend coated test-panels to determine the distensibility of the coating. These crude tests offer considerable information to an experienced observer but the results are qualitative, at best, and not sufficiently accurate. An improved technique for evaluating the properties of paint coatings quantitatively and reproducibly has been developed by the Laboratories. In its latest form it involves wrapping the test specimen around a conical mandrel and computing the elongation limit of the finish from the position of cracks. The experience of the operator is of minor importance in the new procedure.

The property of an organic coating which usually shows the effect of age most quickly is its elongation characteristic. A good finish must be distensible enough to withstand the expansion and contraction of the base material caused by changes in temperature and humidity. The coating also has to remain intact even though mechanically deformed in manufacture or service. Many organic finish coatings meet these requirements



during their early life but become brittle as they age. The rate of degradation in elongation characteristics is therefore used as a measure of the useful life of these films.

The percentage of elongation at fracture of the coating is measured initially, and periodically after normal or accelerated aging. These values are obtained on uniform coatings of controlled thickness on typical metal surfaces. The testing is carried out at constant temperature and humidity and to insure reproducible values the samples, prior to and during the tests, are equilibrated to a closely controlled atmosphere.

By bending a coated panel over cylindrical mandrels of different radii, the convex side is stretched and the percentage elongation of the film be-

fore fracture can be determined quantitatively. The elongation obtained depends on the kind of metal, its thickness, and the radius of the bend. In an early device developed in these Laboratories, the bend was made over six mandrels which ranged in diameter from one-eighth to one inch. This determined limiting values of elongation from 2.8 per cent to thirty-three per cent in six fixed steps.

An improved method, recently developed by the Laboratories, uses a single mandrel, conical in shape and varying in diameter from one-eighth to one and one-half inches. This permits determinations on a single test specimen and gives actual values at fracture instead of limiting values. Since only a single wrapping mechanism is required, the conical-mandrel test equipment is mechanically simpler than that for the multiple cylindrical mandrel and appreciably less ex-

pensive. Cost of equipment and simplicity of operation are important because flexibility tests are widely

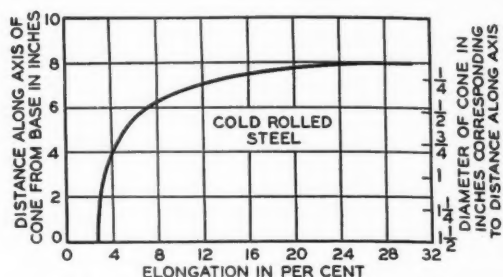


Fig. 2—The elongation limit of a finish can be computed from the diameter of the mandrel where the finish breaks. This limit varies with the backing material

made by both consumers and producers. The conical mandrel for testing finishes is shown in the headpiece.

An investigation of several finishing materials and tests with duplicate panels on both machines showed that the same values are obtained whether the specimen panels are bent over a conical or cylindrical mandrel. To show that no error is introduced by the additional stresses caused by bending over a cone instead of a cylinder, tests were made on finished specimen panels which were scored through to the basis materials at one-inch intervals along the axis of the cone as well as on unscored panels. The experiments indicated that additional stresses caused by the conical mandrel do not affect the tests appreciably. For example, in a rather brittle material with very poor adhesional characteristics, which showed small cracks over a relatively large distance along the mandrel, the character

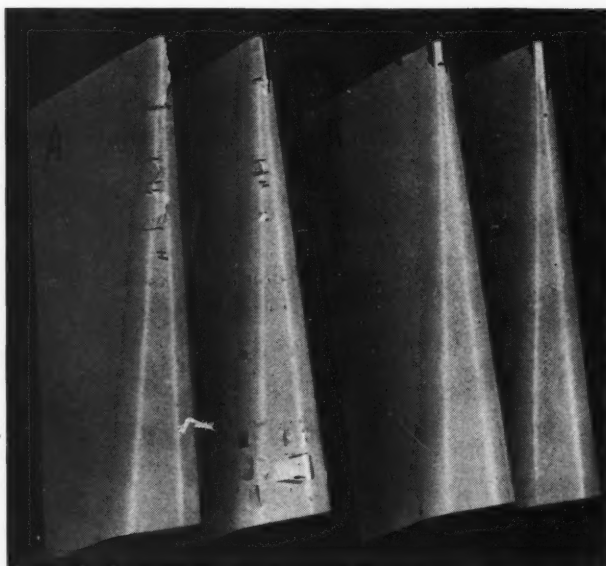


Fig. 1—To prevent the drawbar of the testing machine from injuring the finish, sheets of Kraft paper lubricated with talc are used between the roller and the specimen. The four specimens illustrated were identical but the two shown at the left were tested without the use of slip papers

and extent of the cracks was the same whether the panel was scored or not. This shows that the cross stresses introduced by the cone are low.

The relation between elongation and mandrel diameter is different for various metals and has been separately determined for several of those in common use. Values for one metal are shown in Figure 2. The determination involves measuring accurately the elongation of the outer face of a bent panel. A rough approximation of the elongation can be calculated from the stretch by assuming that the elastic limit of the material has not been exceeded. The error involved by this method ranges from about three-quarters per cent elongation for a mandrel one inch in diameter to about eight per cent for one of 0.15 inch.

When determining the elongation of films more than 0.001 inch in thickness, a correction is usually made for

the added thickness of the finish coating. As in any other elongation determination the speed of stretch must be controlled. A bending rate of 180 degrees around the mandrel in fifteen seconds is usually employed.

To prevent the sliding action of the drawbar from marring the finished surface when testing organic films of low adhesion, slip planes are placed between the drawbar and the finished surface of the test specimen. Two loose sheets of Kraft paper lubricated with talc serve this purpose successfully. Coatings tested with and without slip planes are shown in Figure 1.

The conical-mandrel test has proved to be a useful, reliable and economical tool in studies of organic finishing materials; and it will undoubtedly contribute materially to the development of increasingly durable finishes for telephone apparatus.

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## TELEVISION EXPERIMENTS ON COAXIAL CABLE

*Following completion on May 12 of tests preliminary to the multi-channel telephone use of a 200-mile length of coaxial cable between Stevens Point, Wisconsin, and Minneapolis, the Laboratories engineers, by looping back the coaxial conductors, formed an experimental circuit of 800 miles for the transmission of television signals. Scenes televised in the Minneapolis Telephone Building were transmitted over this looped-back circuit and compared with direct transmission when only a few feet of wire connected the camera and the receiving tube. The difference was imperceptible to most observers although the Laboratory engineers could detect impairments somewhat greater than were observable in the earlier test of 190 miles over the New York-Philadelphia coaxial. Transmission was by carrier with an effective band width of  $2\frac{3}{4}$  megacycles. This transmission, over a total length more than four times as long as that previously obtained over the New York-Philadelphia coaxial, marks a further but by no means a final experiment in the development of coaxial-cable systems for television transmission*



## The 355A Community Dial Office

By J. T. MOTTER

*Switching Equipment Department*

SOME years after dial equipment had been introduced in the larger centers of population, two arrangements of step-by-step dial equipment were made available to the smaller communities. These small dial offices,\* the 350A and the 360A, were designed to operate unattended except for the occasional visit of a maintenance man; all trouble conditions and service calls were referred to a neighboring "operator" office. The 350A, which was the larger of the two, provided practically all the services given by a step-by-step central office, and used similar equipment arrangements. The 360A office provided only a limited number of features, and the equipment arrangement—suited to the requirements of the time—provided more economical service for the majority of offices with less than 800 lines.

At the time these offices were designed, the demand for them was small; equipment for only some 70,000 lines was bought by the entire Bell System prior to 1937. In the past few years, however, the demand has increased enormously—the orders for 1939 alone totaling over 100,000 lines. A contributing factor to this increase is the trend toward the conversion of magneto offices to common-battery operation.

Experience during the past ten years has shown that the majority of offices from 100 to 2,000 lines in size could be better served by equipment that com-

bined the variety of services of the 350A office, and its ability to grow, with the equipment flexibility obtained with universal switch frames, capable of mounting a variety of circuit units, after the manner of the 360A office. The development of such an office was therefore undertaken; and the new office—known as the 355A—has been in production since early in 1939. Besides blending the best features of existing equipment, it has a number of novel features that make it unusually economical, not only in original cost but in the labor of ordering, engineering, and installing. Its flexibility both of circuit features and of equipment arrangements has been amply demonstrated by the ease with which new services have been continually added to care for the widely varying conditions that occur in the field.

These offices are called upon to serve hamlets and towns in all parts of the country, where they must be able to reproduce the types of service existing in each area. In most cases the existing plant, whether farmer-owned 20-party lines or the most modern cable, must be connected with manual and dial offices of whatever variety and vintage. Sometimes the operator offices act as centers of tandem networks to serve a rural area of as much as fifty miles radius, with all toll and manual service for the area concentrated in one building.

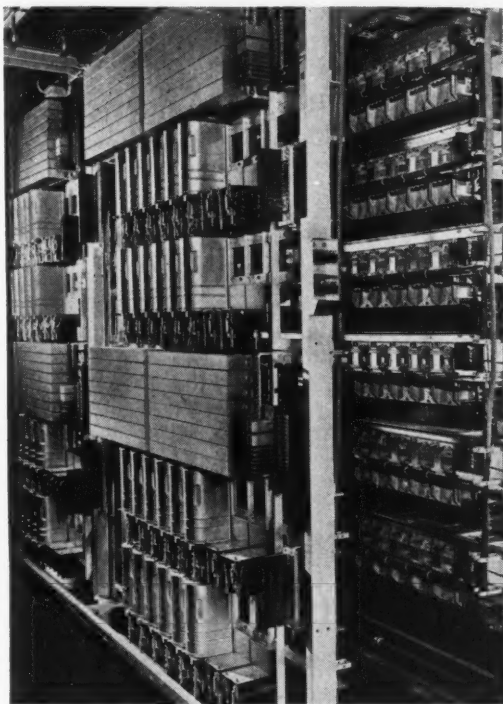
Basic equipment simplicity is secured by using a single size of switch

\*RECORD, August, 1931, p. 562.

frame. The various apparatus and equipment units are mounted on "shelves," which consist of two angle-iron supports welded together by cross struts. Several types of shelves are provided, and drilled and equipped for certain types of equipment such as line finders, selectors, and connectors as well as such equipment as ringing machines, trunks, and alarms. Those used for step-by-step switches carry the multiple banks, and the jacks into which the switches themselves are inserted. If each shelf were arranged with a conventional local cable for extending the jack terminals and miscellaneous wiring to terminal strips, it would be necessary either to provide many varieties of local cable or to furnish fixed combinations of services, which would do much to destroy the economy and flexibility sought. Instead of using local cable on the 355A shelves, therefore, a small distributing ring has been placed at each switch position on the shelf; and all cabling that is individual to each switch is run by the installer directly to the switch jacks through these rings.

Cable brackets are also provided at the ends of the shelves through which cables and loose wiring may be carried vertically up the frame. Each switch frame has its own section of cable rack along the top, so that when the frames are installed, the rack is all in place and lined up except for the cross-aisle rack. This rack with its associated material for mounting may be ordered, as desired, as an assembly. Only the multiple wiring of the banks, and certain leads required for all shelves, such as the alarm, ringing, and tone or interrupter leads, are carried to terminal strips. Many of these features can be noticed in the illustrations.

The line-finder units, shown in Figure 1, have several novel features. Instead of using a line relay and a cut-off relay for each line, a combined line and cut-off relay is provided. In addition a lock-out relay is available

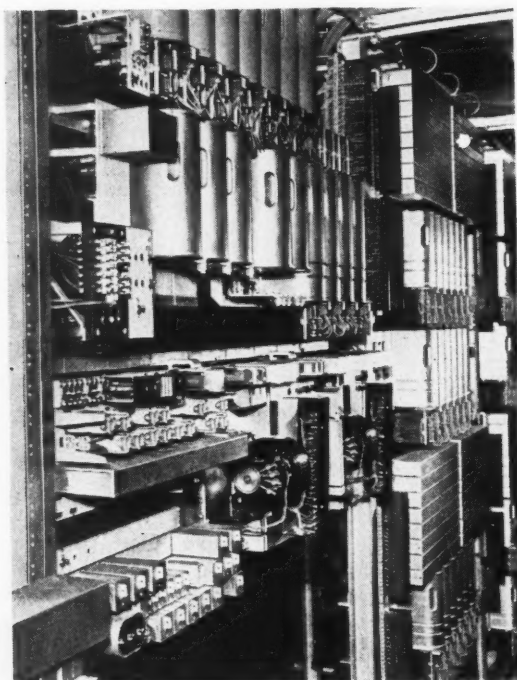


*Fig. 1—Line-finder equipment in a 355A office uses a combined line and cut-off relay*

that may be used on all lines where faults are likely to occur. Without such a relay, a fault in the line would tie up a line finder and its associated first selector until the fault was cleared. The lock-out relay, however, in conjunction with a timing circuit, releases the line finder and associated selector after a short interval and prevents the line from seizing other line finders until the trouble has been cleared. A distributor type of control, using a 206 type selector, is employed to allot the line finders to the calls as they come in, thus providing simple and economical equipment. Instead of

providing separate line-finder units for the various classes of service, such as flat rate, message rate or coin lines, two, three, or four classes may be served by the same group of line finders by assigning the various classes of service to different levels.

Only two types of shelves are provided for all the varieties of selector equipment. One is for local and toll-

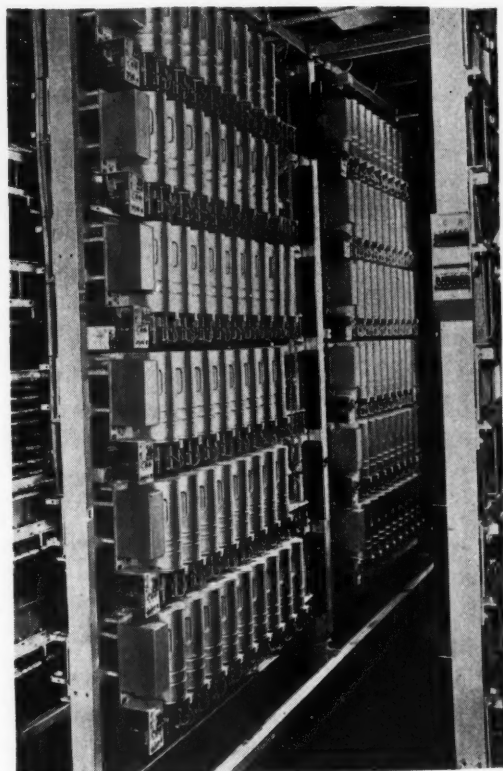


*Fig. 2—Miscellaneous equipment mounts on shelves on the same frames as the step-by-step switches*

intermediate selectors, and the other for toll-transmission selectors. About twenty-five types of connectors are provided for the various possible combinations of service, and one type of shelf will mount any of them. Provision is made for practically all types of ringing that are available in the Bell System.

In addition to these shelves for the usual step-by-step switches, two types are available to accommodate any

combination of trunks and miscellaneous circuits of different kinds. The trunk equipment may be arranged on horizontal strips for mounting on 23-inch relay racks, or on step-by-step switch plates for mounting on the shelves in the usual manner. To accommodate the former type of trunks on the 355A step-by-step frames, brackets are provided on the shelves so that three groups of 23-inch mounting plates can be mounted across the standard frame, each group comprising ten mounting plates. In some offices relay racks may be employed, and to permit the switch-plate type trunks to be mounted on them, a small shelf of four positions has been provided which mounts directly on the relay rack. The ringing plant consists of one or two rotary



*Fig. 3—An installation of selector equipment in a typical 355A office*

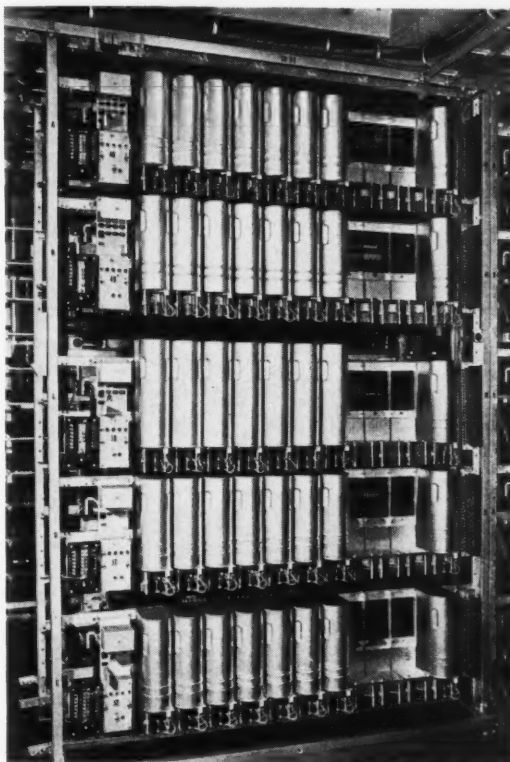
ringing machines\* complete with shaft-driven interrupters for generating all the required tones and codes.

A simple alarm arrangement is used whereby an operator may dial an alarm-checking terminal and tell by presence or absence of one tone or another whether or not trouble exists, and if so, its nature. In addition to the usual alarms, such as individual permanent signals, call blocked, release, fuse and power failure, two new types of alarms are provided which further tend to safeguard service. One is an alarm that operates after a predetermined number of permanent signals have occurred. This might be caused, for example, by branches falling on an open-wire pole line. The other gives an indication of impending cable failure due to moisture, determined by leakage measurements.

The variety of 355A office equipments now available, together with some yet to be added, should care quite economically for the great majority of unattended offices in the Bell System. Low cost of material alone, however, does not insure an economical office. With a choice of so many equipment items, engineering, ordering, and installing costs might well offset low material costs unless special steps were taken to lower them. In developing the 355A office, therefore, definite steps have been taken to minimize effort in engineering, ordering and installing. The framework, frame equipments, floor plans and cabling have been so designed that the majority of offices may follow typical patterns. Such floor-plan patterns have been standardized for typical offices of 400, 800, and 1500 lines; and two forms have been prepared which can readily be filled in to serve as complete speci-

fications. One form serves as an order for the material, and the other as a specification for the installer.

The circuit and equipment design is such that practically all apparatus



*Fig. 4—Connectors in a 355A office*

in an office is mounted and wired on switch shelves or units during manufacture. This provides packages of a size and arrangement convenient for ordering and installing without restricting flexibility. The switch frames are all drilled and tapped so that any combination of shelves may be arranged on the fewest frames that will suit the needs of any particular installation. All shelves are arranged with fuse panels, alarm relays and keys, traffic registers, terminal strips, and cable brackets in corresponding positions. In this way, maintenance points will always be found in the same locations regardless of the fea-

\*RECORD, April, 1940, p. 243.

tures and the arrangement of shelves.

Orders are anticipated for 300 or 400 of these offices a year. In view of this demand and the wide variety of options to be exercised, particular attention has been paid to the standardizing of the engineering of individual installations. Most of the jobs are small, averaging perhaps below 300 lines, and the budget for any particular office is necessarily small. On the other hand, considerable detail engineering is required for each office to prepare an order for material, to give the installer the information he needs, and to maintain an adequate plant record. For jobs of this size it is

preferable for the Telephone Companies to do their own engineering, and the order forms provided make this a comparatively simple matter.

The installing specification provides blanks that serve as job drawings when filled in as recommended. These forms cover traffic diagram, frame equipment, floor plan and inter-switch cross-connections. In addition, complete wiring lists have been provided so that when the circuits applying to a particular job are chosen, the interconnections required between equipment units are easily specified to serve first the installer and later the maintenance forces.

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### "SCIENCE, PHILOSOPHY AND RELIGION"

*"Karl Darrow, of the Bell Telephone Laboratories, writes one of the most valuable contributions to the volume before us. He describes, accurately and not with the allusiveness which is too often a pretentious avoidance of careful thinking, the various revolutions in the fundamental ideas of physics which have taken place during the last half-century. His paper ends with the blunt inquiry: 'But what has all this to do with the democratic way of life, or with the contrast between democratic and totalitarian systems?' He answers:*

*'So far as the development of physics in particular and science in general is concerned, what it seems to require is a supply of talented people enabled and permitted to go their own ways, so that discovery may occur in whatever logical or capricious or ironical ways may be chosen by destiny. Non-interference is essential. If a government discourages some doctrine of physics because of a fancied clash between it and some political or economic dogma, it is adverse to physics. (Other sciences are more exposed to this danger, but even physics has not been exempt.) If a government impedes the free passage of scientific men or scientific writings to and fro across its frontier, it is adverse to the development of science even within that frontier. If a government denies opportunity to a group which has a great aptitude for science, it is doing harm to science within its own dominion, though some of the harm may be repaired by the benefit to science in other countries from the resulting emigration. If a government extinguishes a class which by breeding and inherited tradition and leisure is devoted to things of the mind, it is doing irrevocable harm to science. Everyone knows that it is mainly in totalitarian states that these things happen.'*"

—From a review in "Nature" for March 29 by Ernest William Barnes, Bishop of Birmingham and a mathematician of distinction.



## New Dial-Testing Machine

A. SCHREIBER

*Switching Apparatus Development*

**I**N LIFE tests on dials, the use they get during their normal life is duplicated in a very short time. To give reliable results the machine which operates them must simulate closely the action of a subscriber or operator. In early testing machines a finger or other device, which revolved at a constant speed, engaged the dial and suddenly accelerated it to the speed of the mechanism. When fully wound, the dial was released and permitted to return to normal under control of its own governor. The sudden acceleration was greatly in excess of that which an operator could produce and resulted in much greater ratchet wear in laboratory tests than was observed in corresponding field tests.

Since many dials are ordinarily tested simultaneously, the speed of

the machine had to be adjusted initially to allow sufficient time for the slowest dial on test to return to normal before the cycle was repeated. During the test, failure of one of the dials to return to normal within the allotted time, either because its speed decreased or from sticking, would cause the dial to operate improperly and a considerable number of such operations might occur before the condition was observed.

To correct these shortcomings a pneumatic testing machine has been developed by the Laboratories. It has an air piston which drives a crosshead to which ten individual dials are connected by cords wound around grooved finger wheels. Electrically controlled valves admit air to the piston at the beginning of the wind-up

stroke and release it at the end of that stroke; the piston is then returned by retractile springs. Needle valves are provided in the intake and outlet openings to control the speed of the operating and release strokes. The inlet valve of each unit is operated by a series circuit through the off-normal springs of all ten dials under test. If any dial fails to return to normal the inlet valve will not open and the test automatically stops so that every failure of this type is detected. There is no delay between the return of the last dial to normal and the succeeding stroke. This permits increasing substantially the total dial cycles per day.

Starting from rest the crosshead is accelerated to a steady speed and the motion of the dials on the wind-up is adjusted by the needle valve to be almost identically that given by the subscriber or operator. With the inlet needle valve the machine can also be adjusted to the wind-up speed of a subscriber or to the faster action of an experienced operator. The outlet needle valve is always adjusted so that the crosshead returns on release at a speed greater than that of any dial. The wind-up cords are thus slack and permit the dials to return freely under their own governor action.

In the testing machine, there are five individual units, each of which accommodates ten dials. These units are assembled in a cabinet and normally operate independently so that dial failures on one unit will not stop the tests on others, but they can also be interconnected to act together. Phenol-fibre panels hold the dials at the conventional angle. Each unit has separate control switches and is equipped with its own counter. Individual lamps operated by the pulsing contacts of each dial permit observation of the pulsing during the test and there are jacks for taking oscillograms of any dial without removing it.

A portable unit has also been provided to permit making the dial tests in humidity or temperature-controlled rooms. In this case the crosshead is replaced by a series of rotating discs driven from the air piston by gearing. The dials are operated by cords wound around these discs. All the operating features of the larger machine are retained.

This new testing apparatus not only greatly shortens the time required for dial tests but it gives results which are more representative of service conditions than apparatus that had previously been employed.

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THE PRIZE PAPER award of the Basic Science Group of the A.I.E.E. New York section was received by R. I. Wilkinson for his paper "*The Theory of Measurement of Linear Quantities by Scales with Fine and Coarse Rulings.*" Mr. Wilkinson presented the paper, along with other contestants, at a meeting of the Group held in the Engineering Societies building on April 24



# Adjustable Filters for the 2B Pilot Channel

By F. S. FARKAS

*Transmission Networks Development*

IN THE three-channel carrier systems used for open-wire circuits, a single-frequency test current, commonly called a pilot, is applied continuously to measure the change in line attenuation with temperature and weather conditions, and to set in operation the apparatus that corrects that change. The complete circuit traversed by the test current, together with the regulating apparatus, is called a pilot channel; one is provided for each direction of transmission of a carrier system. For the three types of system, CN, CS, and CU, each of which have different frequency assignments, there are thus six pilot channels, each having its own frequency. Each is located between the carrier frequency and the transmitted sideband of the middle voice channel. They are placed about 50 cycles from the carrier frequency so as not to interfere with the sideband, which begins about 250 cycles from the carrier. In the early carrier systems, the cut-off frequencies of the channel band filters were not precisely located, and it was necessary to adjust the carriers from their nominal frequencies in some cases as much as 350 cycles to enable the sideband to be transmitted efficiently by the particular filters provided for the system. The pilot fre-

quencies were correspondingly adjusted, and thus the narrow band-pass pilot filters had also to be of the adjustable type. An adjustable pilot-channel filter is not required for the latest models of type-C carrier systems, since the channel filters are constructed to such accurate attenuation limits that the carrier frequencies may be fixed, but since the 2B regulator is designed to work with all existing systems, the adjustable feature was retained.

Besides having their pass band adjustable, the pilot-selecting filters must meet a number of other exacting requirements. Since they are bridged across a 600-ohm circuit at the output of the receiving amplifier at each terminal and across the output of amplifiers in each direction at repeater points, they must have high input impedance so as to give low bridging loss at frequencies outside their passed band, and they must have steep attenuation characteristics on each side of their pass band to avoid

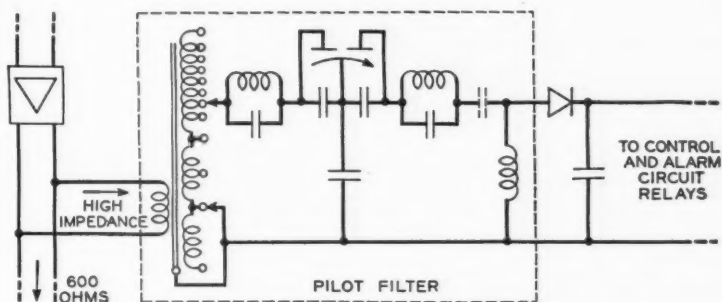


Fig. 1—The pilot filter circuits include an input transformer, filter, and impedance corrector

admitting speech or carrier frequencies to the regulating circuit.

The pilot filter developed to those requirements is shown in schematic form in Figure 1. It is composed of a transformer, a filter section, and an impedance corrector. The transformer, which is located on the input side of the filter, raises the low impedance of the filter section to a high impedance suitable for bridging across a 600-ohm circuit. The low impedance winding of this transformer is provided with taps to permit adjustment of the input power to the amount necessary for the satisfactory operation of the control and alarm circuits of the 2B regulator. The impedance corrector, which resembles a half-section high-pass filter, is located at the output of the band filter. It is represented in the schematic by the dotted series condenser

and by the shunt coil, and serves to transform the high impedance of the rectifier circuit to a suitable terminating impedance for the filter. The shunt coil of the impedance corrector also provides a d-c path for the rectified current, which operates the regulating and alarm circuits. The series condenser of the impedance corrector is actually combined with the series condenser of the filter section, and for this reason is shown dotted in the diagram.

The filter section is a simple three-element "T" type of structure consisting of a tuned coil and condenser in the series arms and a condenser in the shunt arm. The series condensers of the filter are each divided into two parts: one a fixed and the other a variable unit. The variable condensers have equal capacitance, and

their rotors are connected both electrically and mechanically by a metal shaft. By varying the rotor position of this condenser, equal amounts of capacitance may be added to or subtracted from each of the series arms. This adjustment changes the position of the pass band of the filter. The capacitance values employed in the variable condenser unit are such that the pass band of the filter may be adjusted over a frequency range of at least  $\pm 350$  cycles for the high-group pilots. These pass-band adjustments are sufficient to cover the variations of the pilot frequencies

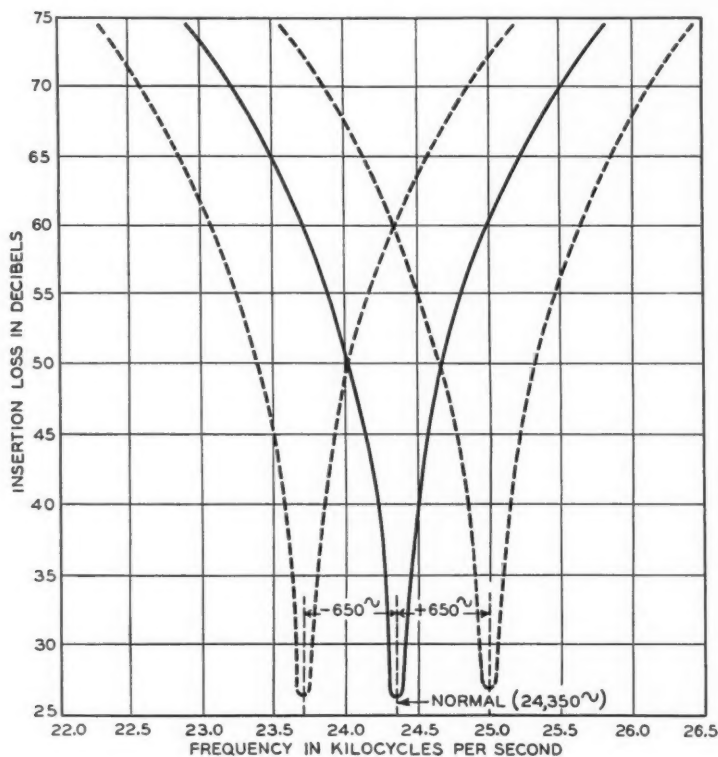


Fig. 2—Typical insertion loss characteristic of pilot filter showing its adjustment range with frequency

found in the telephone plant. In practice, the pilot channel adjustments are made with an ordinary screwdriver. This screwdriver engages in an insulated screw, which is mechanically coupled to the shaft of the condenser.

The elements of each series arm of the filter, excluding the air condenser, consist of the coil, fixed condenser, and a small trimmer condenser in parallel with the coil for initial adjustment purposes. These elements are grouped in a hermetically sealed unit. The connections from these three-element assemblies to the stator of the adjustable condenser are the high potential points of the filter circuit. To provide adequate insulation at these points, the leads are brought out through long hard rubber bushings which offer a very high insulation resistance path to ground. Because of this high insulation, the changes in mid-band loss that occur with variations in humidity are minimized, and there is eliminated the consequent possibility of false line regulation. The six pilot channel filters now available will pass frequencies of 9450, 10,630, 19,750, 21,450, 23,750, and 24,350 cycles with the air condenser adjusted to its mean position.

The insertion loss characteristic of a typical 24,350-cycle pilot filter and the range of adjustment of its band are shown in Figure 2. The dotted loss characteristics which have mid-band frequency positions of 23,700 and 25,000 cycles correspond to maximum and minimum capacitance in the adjustable air condenser. At mid-band there is an insertion loss between the

600-ohm bridged line and rectifier circuit of about 27 db, 18 db of which is reflection at the junction of the transformer and the 600-ohm line and 9-db transmission in the filter itself. The filter loss corresponds to an over-

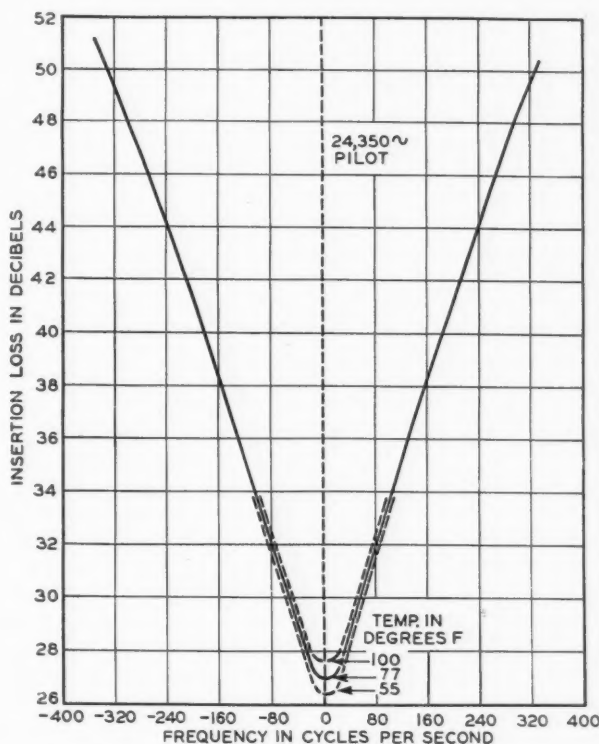


Fig. 3—Stability of band location with temperature of a typical pilot filter

all circuit "Q," or ratio of reactance to resistance, of 260. In this ratio the coils are the controlling factors and any appreciable reduction in filter loss would necessitate the use of very large and costly coils.

The input impedance of this particular pilot filter over its pass-band range is of the order of 300,000 ohms at its bridging terminals. This means a bridging loss of about .01 db when connected across the 600-ohm line. Because of the type of filter section employed, maximum bridging loss occurs in the mid-channel band at

those frequencies corresponding to the pass-band range of the pilot filter, and this bridging loss decreases rapidly for frequencies away from the neighborhood of the pilot.

Precautions must be taken to avoid an appreciable change in the attenuation characteristic of the filter due to fluctuations in temperature and humidity encountered in normal service. A small shift in frequency of its attenuation characteristic might translate the pass band sufficiently to result in false line regulation. To secure the needed stability, the inductance of the coils should have a temperature coefficient either equal in magnitude but opposite in sign to that of the condenser, or ideally, they both should have zero temperature coefficients. It has been possible to secure the desired stability by combining mica condensers with coils using core materials having a controlled negative temperature coefficient that offsets the positive coefficient of the condensers.

The general effect of temperature on the attenuation characteristic of a typical filter is shown in Figure 3. For temperatures between 55 and 100 degrees Fahrenheit, the band location remains unchanged due to the high degree of stability of the resonant frequency of the coils and condensers. The 0.6-db change in loss from the normal 77-degree characteristic, as shown by the 55-degree and 100-degree dotted characteristics in Figure 3, is due to the variation in effective resistance of the coils and condensers caused by temperature changes.

The pilot filters employed in the 2B regulator occupy about one-half the space needed for the coupled tuned circuits used in previous regulator equipments. They are more selective in discriminating against frequencies outside their pass ranges, more stable to the temperature and humidity variations encountered and more economical than their predecessors from the plant standpoint of adjustment and maintenance.

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THE NATIONAL PRIZE FOR INITIAL PAPER *presented in 1940 was awarded by the American Institute of Electrical Engineers to V. E. Legg and F. J. Given. The title of the paper was "Compressed Powdered Molybdenum Permalloy for High-Quality Inductance Coils"; it was presented at the 1940 winter convention of the Institute held in New York City. Presentation of the awards will be made at the summer convention to be held in Toronto in June*



## Contributors to this Issue

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J. T. MOTTER joined the Equipment Development Department of the Laboratories in 1929. After a period in the trial installation group, he transferred to switching equipment where he was concerned with the development of step-by-step equipment for central offices and community dial offices until 1932. After installation and maintenance work with The Chesapeake and Potomac Telephone Company in Washington, he returned to the Laboratories in 1936, and has continued his work with step-by-step equipment.

W. A. KNOOP first joined the Western Electric Company in 1913, when he spent six months assembling train-dispatching selectors. Following this, he spent two years at Pratt Institute, and then joined the Research Laboratories.



*J. T. Motter*

Here he first worked on the vacuum tubes for the 1915 Arlington-Paris radio demonstration, and then engaged in investigations of vacuum tubes in oscillating circuits and of the noise in vacuum tubes. In 1926 he transferred to the submarine cable telegraph group, and spent some time in the Azores and England installing and testing equipment for the first permalloy-loaded cable. Since 1932 he has been with the television research group where he has been engaged in the design and development of television equipment.

HOWARD MORRISON spent a year and a half testing machine-switching telephone equipment for the Western Electric Company, and then entered Worcester Polytechnic Institute in the fall of 1923. At the end of his junior



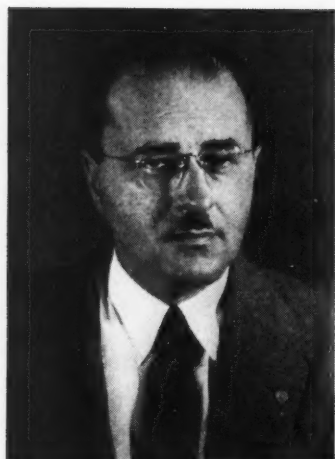
*W. A. Knoop*



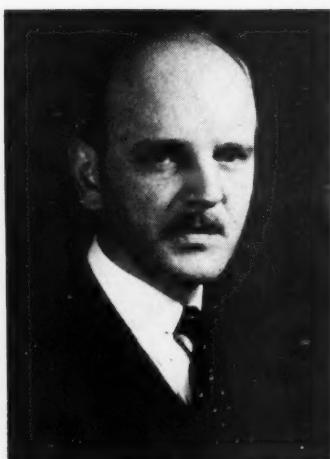
*Howard Morrison*



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year, he joined the Systems Development Department of the Laboratories as a co-operative student, and spent fifteen months in the local systems laboratory. After receiving the B.S. degree in 1928, he rejoined the Laboratories, and, with the Special Products Department, engaged in the design of broadcast transmitters. Since 1930 he has been concerned with the design of aircraft radio receivers.

W. W. STURDY was graduated from M. I. T. in 1924 with the S.B. degree and joined the D & R in July of that year. His work there included transmission testing apparatus and studies of transmission maintenance. Later he was concerned with the design of test apparatus and field tests in connection with the coördination of power lines for railway electrification and telephone lines. Last December he was called for active duty as a Captain of the Signal Corps.

H. G. ARLT joined the Laboratories in 1923 after receiving the degree of M.E. from Stevens Institute of Technology. Following a short period of preparing apparatus specifications, he became engaged in the engineering of finishes and materials in the Physical Laboratory. Mr. Arlt continued in this field in the Materials Department and the Chemical Laboratories. He is now directing the work on finishes and that on the development of the chemical requirements of various organic materials.

F. S. FARKAS joined the Engineering Department of the Western Electric in 1920 as a technical assistant, and on completion of the technical assistant's course in 1923, continued evening courses at the Polytechnic Institute of Brooklyn, receiving an E.E. degree in 1929. He was first associated with the drafting, and then with the specifications group of the Apparatus Development Department. In 1926 he transferred to the Network Development Department where he has since engaged in the study and development of transmission networks, such as filters and equalizers for carrier telephone and program systems.

J. G. NORDAHL received the B.S. degree in E.E. from the University of Washington in 1925 and immediately joined the technical staff of the Laboratories where he was associated with the development of broadcast and other radio transmitters. Since the latter part of 1928, he has been associated with the development of aircraft and point-to-point radio transmitters.

ALBERT SCHREIBER, of the Switching Apparatus Development Department, had for many years been responsible for setting up and maintaining all test equipment and the design of special testing apparatus for the Dial Apparatus Laboratory. Mr. Schreiber's death occurred on November 14 and the December issue of the RECORD carried his obituary.